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Managing the Unknown

U.S. Government Use of Commercial Card Technology: *A Case for the Change in Military Card Distribution Policy*
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Nonstationary Root Causes of Cobb's Paradox
Lt Col Joseph W. Carl, USAF (Ret.) and Col George Richard Freeman, USAFR (Ret.)

Embracing Uncertainty in DoD Acquisition
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Adaptation of Porter's Five Forces Model to Risk Management
John F. Rice

Cost Growth: *Perception and Reality*
Col Mark F. Cancian, USMCR (Ret.)

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U.S. GOVERNMENT USE OF COMMERCIAL CARD TECHNOLOGY: A CASE FOR CHANGE IN MILITARY CARD DISTRIBUTION POLICY

Richard J. Palmer, Mahendra Gupta, and Rodney Dawson

The U.S. Government has used bank commercial card technology since the 1980s to simplify and significantly reduce the cost of the process to acquire low-value goods and services. However, the transition from traditional payment tools to commercial card payment has been slow in recent years. The data presented in this article reflect that change in military practice regarding purchase card distribution is a major contributor to the observed slowdown. Given developments in purchase card technology and the maturation of card spending controls, it may be an appropriate time for the military to revisit its purchase card distribution policies. The ability of the U.S. Government commercial card program to deliver the benefits expected from card use call for this re-examination.

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NONSTATIONARY ROOT CAUSES OF COBB'S PARADOX

Lt Col Joseph W. Carl, USAF (Ret.) and
Col George Richard Freeman, USAFR (Ret.)

Cobb's Paradox states, "We know why [programs] fail; we know how to prevent their failure—so why do they still fail?" One possibility is that we do not really know why programs fail and there is no paradox. Another possibility is that some of the problems that lead to program failure may not be susceptible to practical solution, so that continued failure is not paradoxical. This article defines what we mean by nonstationary root causes of program failures, and identifies 10 such causes. Requirements volatility, funding stability, process immaturity, and lack of discipline are often cited among the reasons. The article ends with recommended approaches to mitigate the effects of influences from the environment that change over time—nonstationary effects.

Managing the Unknown

355 **EMBRACING UNCERTAINTY IN DoD ACQUISITION**
1SG David E. Frick, USA (Ret.)

Uncertainty is an inherent, unavoidable aspect of life that has a significant impact on program or project management, and acquisition in general. The treatment of risk management within the Department of Defense (DoD) as a formal element of acquisition is a topic discussed extensively in the acquisition profession. DoD fares no better than industry in the number of projects or programs that fail to meet cost, schedule, or performance baselines. This article suggests that, overall, the DoD approach to uncertainty is flawed, and that we need substantive changes to the structure and policies of acquisition to become more effective in the discipline of program management.

375 **ADAPTATION OF PORTER'S FIVE FORCES MODEL TO RISK MANAGEMENT**
John F. Rice

Prominent tools for assessing and managing risk include risk cubes, risk burndown charts, and automated risk management software. They are generally lacking, however, in accommodating ideation and brainstorming to identify potential problems. A suggested approach for improving the process is to apply strategic management models currently used as commercial best practices. Many are directly applicable and adaptable to systems engineering processes including risk management. This article presents traditional risk tools and introduces a complementary management model tailored to the identification, scoring, and tracking of potential program threats. Additional management models are presented for further investigation and adaptation.

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389 **COST GROWTH: PERCEPTION AND REALITY**
Col Mark F. Cancian, USMCR (Ret.)

From the Government Accountability Office to think tanks and politicians, everyone agrees that rising weapons costs are evidence of acquisition system failure. However, in the complaints about cost growth, many basic questions go unanswered: Is cost growth always bad? What is cost growth? How serious is it? Why does it matter? What tools are really effective in combating it? A close examination of these questions reveals many misconceptions. These misconceptions lead acquisition executives to implement an endless cycle of reforms that begin with high hopes, yet prove disappointing in execution. This article analyzes the nature of cost growth, assesses its practical effects, surveys the recent literature, and offers insights about which actions are most effective.

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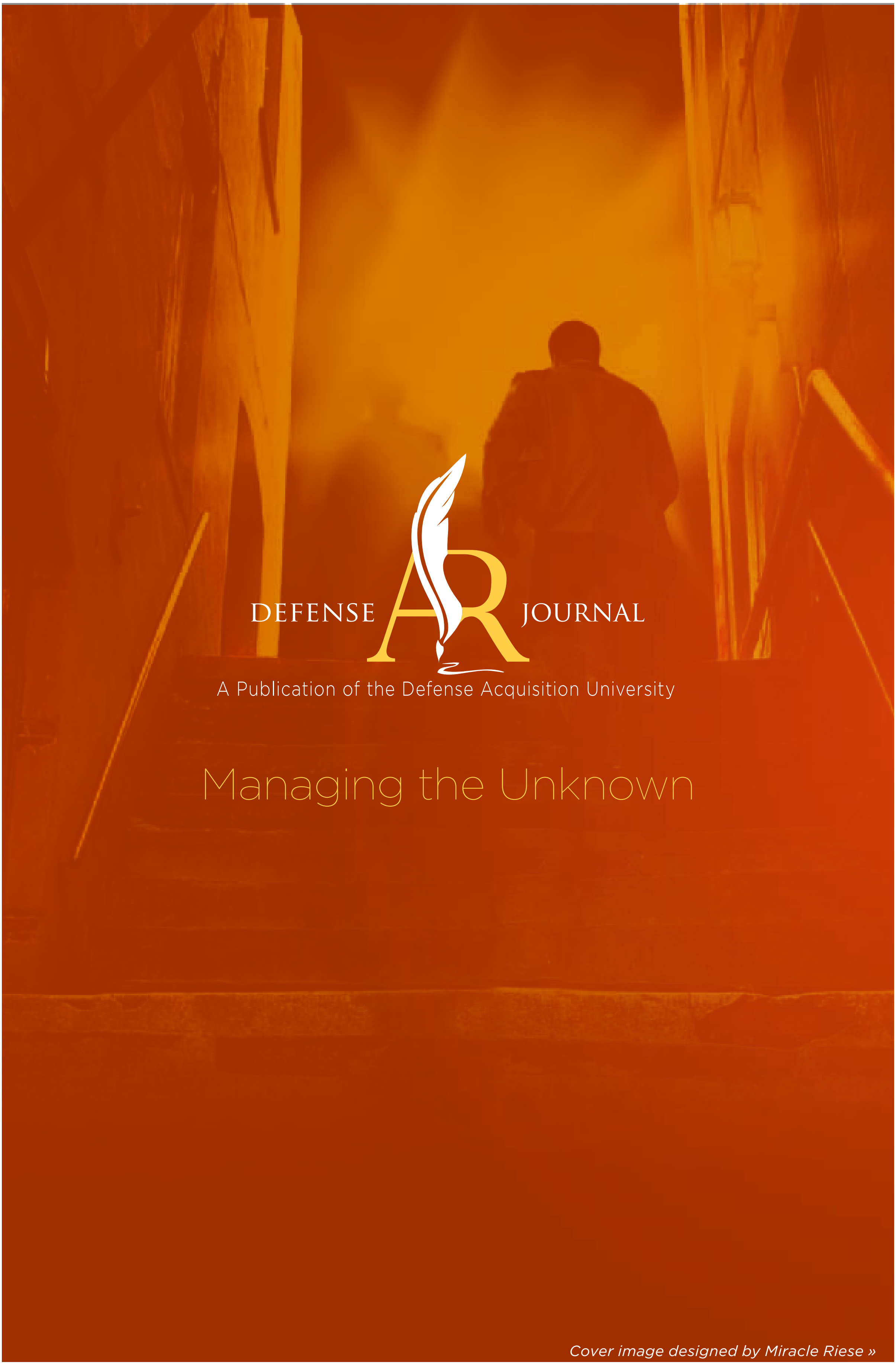

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Managing the Unknown

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Remarks
FROM THE EXECUTIVE EDITOR

By way of introduction, I am Larrie Ferreiro, the director of research at the Defense Acquisition University (DAU) and the new executive editor for the *Defense Acquisition Review Journal (ARJ)*. I am stepping into the post that Dr. Paul Alfieri so ably occupied for the previous 5 years. As Paul mentioned to you in the previous edition, I come from the naval side of defense acquisition. I was a naval architect for the U.S. Navy and the Coast Guard for 25 years before joining DAU to teach systems engineering. During that time, I had the opportunity to serve in various posts overseas (including as an exchange engineer with the French navy, where I designed French warships) and several turns in industry. Since joining DAU, I have worked with many different acquisition agencies across the Department of Defense (DoD) and at the Department of Homeland Security.

It comes as no surprise that the defense acquisition process, and its problems, have evolved considerably in the 30 years I have worked in the field. The cold war pitted the West against a single, known adversary; and in the very broadest of terms, defense acquisition was focused on maintaining superiority over that potential enemy. When the Berlin Wall fell in 1989, no one was certain who the next potential foe would be. Now a generation later, we face a multitude of threats, from terrorism to regional instability, and our forces may have to pivot on a dime from one moment to the next. Even more unsettling, we simply cannot know with certainty what the next threat may be or from where it may come.

It is therefore opportune that the current issue of *Defense ARJ* is themed "Managing the Unknown." The concept is of course not new. Norman Augustine, in his classic 1982 book *Augustine's Laws*, famously stated that "two types of uncertainty plague most efforts to introduce major new products: known-unknowns and unknown-unknowns" (Augustine, 1982, pp. 49–50). The five articles in the current issue address some aspect of managing the unknown—whether risk, accelerating technology, or managing economic and environmental influences—all examine and embrace the uncertainty inherent in large, complex programs.

Richard J. Palmer, Mahendra Gupta, and Rodney Dawson lead off with an examination of the unexpected decline in the government credit-card usage of defense agencies, long considered an important cost-saving practice, and propose ways to redress the decline. Joseph W. Carl and George Richard Freeman explore how to control aspects of programs, variable over time, that contribute to program failures—a partial response to the lament of a Canadian official, Martin Cobb (1995): “We know why projects fail, we know how to prevent their failure—so why do they still fail?” (p. 1). David E. Frick advocates that Congress, the DoD, and industry all embrace uncertainty in managing program budgets, schedule, and performance. John F. Rice suggests the programs use alternative business risk models, in addition to traditional ones such as the *risk cube*, to account for the external and internal forces that can make or break a program. Rounding out this edition, Mark F. Cancian examines the myths and the realities of weapons cost growth; he also evaluates the “What if” questions that often arise out of unanticipated growth.

The theme, “Managing the Unknown,” is also appropriate in the current acquisition environment for two reasons. First, the Weapon Systems Acquisition Reform Act of 2009 made sweeping changes to the DoD 5000 framework, and pending legislation may further impact the way the DoD acquires systems and services. The full impact of this legislation will not be understood for some time. Second, one of the most important jobs in defense acquisition will change hands, most likely by the time you read this edition. On June 30, 2010, DAU President Frank J. Anderson is retiring after 10 years of exemplary service to this community and 44 years serving the United States of America. DAU is central to the revitalization of the defense acquisition workforce, and the new president will play a key role in implementing the reforms now underway.

Both defense acquisition and DAU itself, therefore, are on the cusp of another transformation. In the coming months and years, the *Defense ARJ* will be transforming as well. I look forward to helping guide all of you through that process.

Dr. Larrie D. Ferreiro
Executive Editor
Defense ARJ

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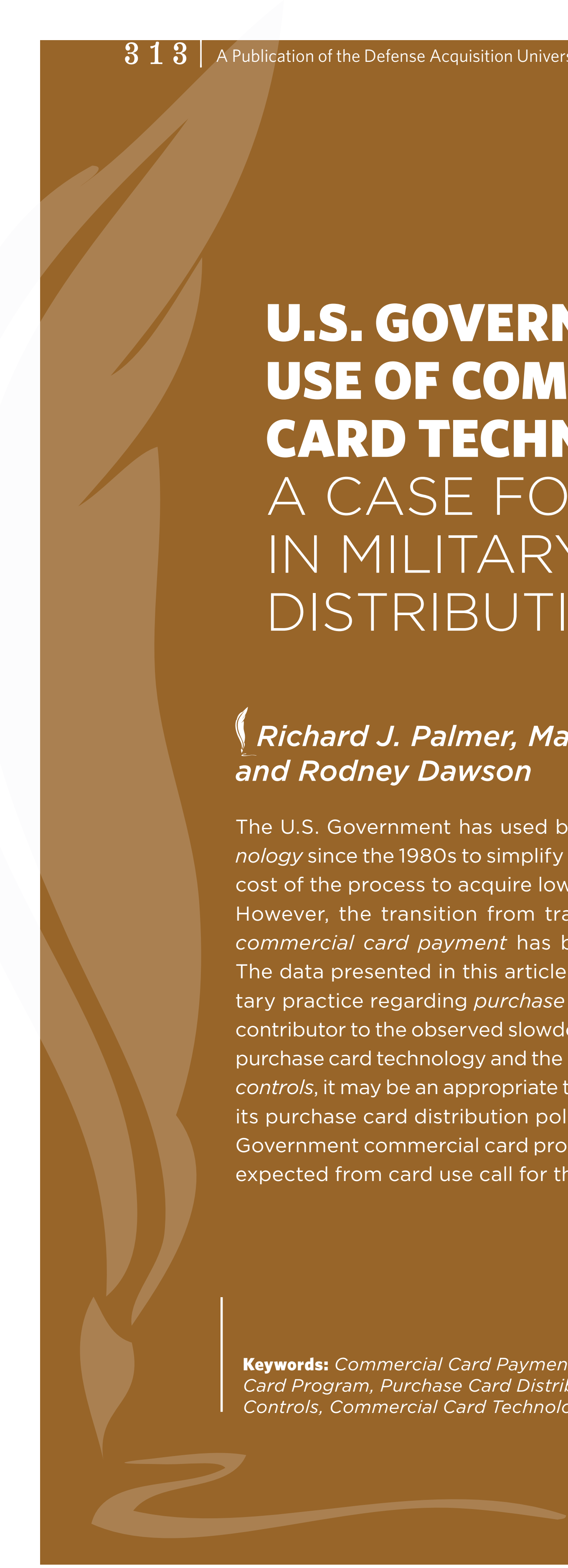


U.S. GOVERNMENT USE OF COMMERCIAL CARD TECHNOLOGY: A CASE FOR CHANGE IN MILITARY CARD DISTRIBUTION POLICY

Richard J. Palmer, Mahendra Gupta, and Rodney Dawson

The U.S. Government has used bank *commercial card technology* since the 1980s to simplify and significantly reduce the cost of the process to acquire low-value goods and services. However, the transition from traditional payment tools to *commercial card payment* has been slow in recent years. The data presented in this article reflect that change in military practice regarding *purchase card distribution* is a major contributor to the observed slowdown. Given developments in purchase card technology and the maturation of card *spending controls*, it may be an appropriate time for the military to revisit its purchase card distribution policies. The ability of the U.S. Government commercial card program to deliver the benefits expected from card use call for this re-examination.

Keywords: *Commercial Card Payment, DoD Purchase Card Program, Purchase Card Distribution, Spending Controls, Commercial Card Technology*

image designed by Tia Gray »

PAPERWORK REDUCTION
PROVIDER DISCOUNTS
TRANSPARENCY

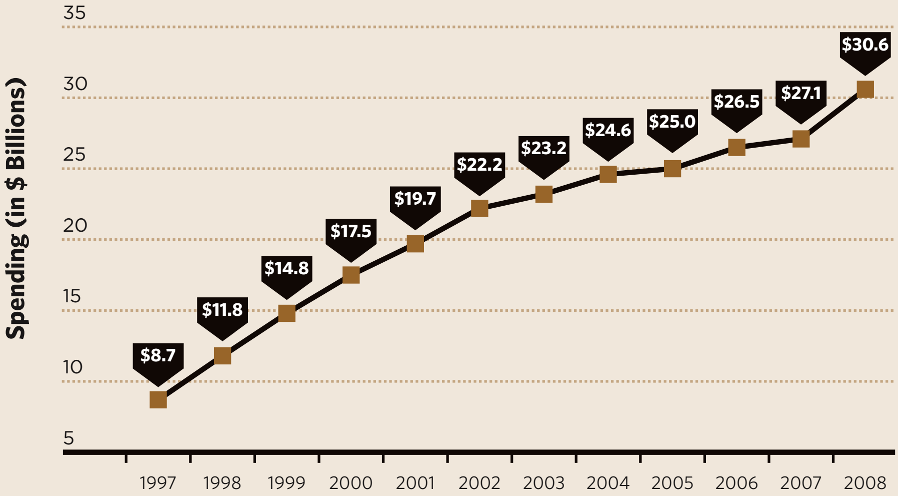
The U.S. Government has used bank commercial card technology since the 1980s to simplify and reduce the cost of the process to acquire goods and services. The term "commercial cards" includes purchase, travel, and fleet cards. Generally, purchase cards are used to acquire low-value, nontravel-related goods and services; travel cards are used to facilitate employee travel on government business, e.g., airfare, hotels, and auto rentals; and fleet cards are used to support employee purchases of fuel and other automotive services for government vehicles.

The benefits derived from card use vary by type of card, manner of card use, and degree of integration with the procedural and technological fabric of the acquisition process. Purchase cards reduce or eliminate the paperwork associated with requisitions, purchase orders, invoices, and payments. The General Services Administration (GSA) estimates that purchases under $2,500 account for only 2 percent of total Federal Government spending but 85 percent of total procurement transaction volume (GSA, 2007). Estimates of Federal Government cost savings by use of purchase cards have ranged from $54 to $92 per transaction (GAO, 1996; DoD, 1998). Further, purchase cards have been found to reduce the time required to process paperwork transactions by 2 to 6 weeks (GSA 2006). The benefits of travel cards include convenience to the government agency; efficiency and transparency in travel spending, reporting, and management; and the elimination of cash travel advances. Employees can charge travel expenses, thus enabling the government to avoid the expense and reduce the risk associated with controlling cash advances, while enhancing visibility of spending activity. Aggregation and enhanced visibility of travel spending activity can be very important to obtaining discounts on airfare, hotels, or auto rentals. A recent survey of 824 public- and private-sector organizations reflected that organizations driving a higher percentage of their travel spending onto their travel cards reported higher discounts with travel service providers (Gupta, Palmer, & Markus, 2009).

While the value proposition of transitioning from traditional payment tools to commercial card payment technology appears sound, transition of government spending to commercial cards has slowed down in recent years, particularly in relation to the overall government budget. Figure 1 shows commercial card spending has increased from $8.7 billion in 1997 to $30.6 billion in 2008. However, Figure 2 shows that commercial card spending as a percentage of budgeted spending by the U.S. Government is currently 1.03 percent—down from the high water mark of 1.10 percent in 2002. Indeed, U.S. Government commercial card spending as a percent of budgeted spending had been in a steady state of decline between 2002 and 2007, rebounding modestly for the first time in 2008.

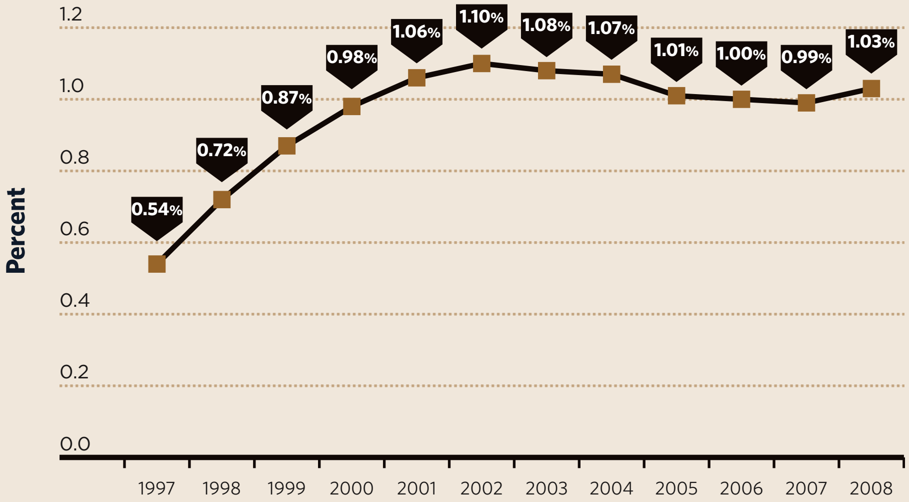
The purpose of this article is to identify the underlying dynamics associated with commercial card spending by the U.S. Government and its impact on governmental efficiency and cost savings. Since the military services and defense agencies comprise a significant component of

FIGURE 1. TOTAL COMMERCIAL CARD (PURCHASE, TRAVEL, AND FLEET) SPENDING BY U.S. GOVERNMENT (2000–2008)



Note. Adapted from U.S. General Services Administration, GSA SmartPay Performance Summary at http://www.gsa.gov/Portal/gsa/ep/contentView.do?contentType=GSA_OVERVIEW&contentId=11490.

FIGURE 2. COMMERCIAL CARD SPENDING AS A PERCENTAGE OF BUDGETED SPENDING BY U.S. GOVERNMENT (2000–2008)



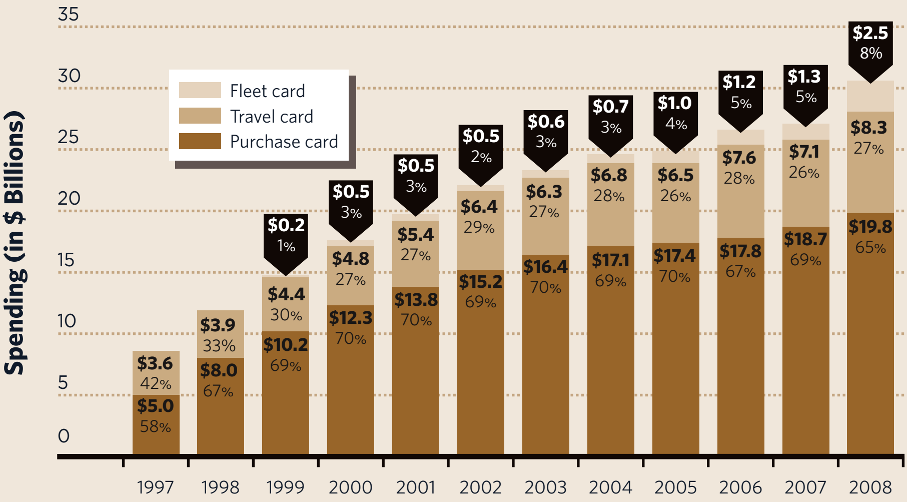
Note. Adapted from federal budget data found in the Final Monthly Treasury Statements of Receipts and Outlays of the United States Government, Department of the Treasury Financial Management Service. Commercial card spending data available at GSA SmartPay Performance Summary at http://www.gsa.gov/Portal/gsa/ep/contentView.do?contentType=GSA_OVERVIEW&contentId=11490.

government commercial card use, special attention will be given to their role in commercial card use trends. Finally, recommendations to enhance commercial card spending will be proposed.

Examining Commercial Card Use

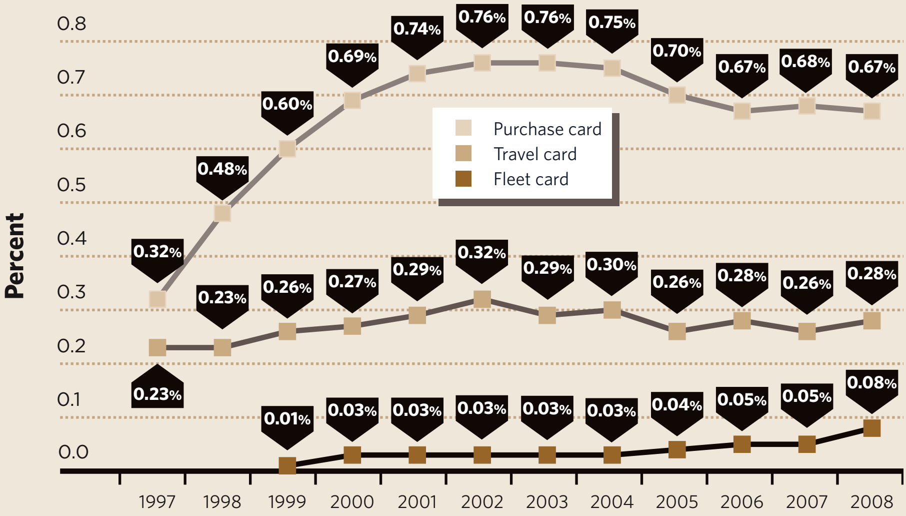
To dissect the longitudinal pattern of commercial card spending, we begin by examining its component parts. Figure 3 shows that purchase card spending has accounted for the majority of commercial card spending by the U.S. Government since 1997. Since 2000, purchase cards have accounted for 65 to 70 percent of commercial card spending. In Fiscal Year 2008, for example, the U.S. Government spent $30.6 billion on commercial cards. Of this amount, $19.8 billion, $8.3 billion, and $2.5 billion were spent on purchase, travel, and fleet cards, respectively. Further, Figure 4 shows that purchase card spending as a percent of budgeted government spending has experienced the greatest decline over the past 5 years, falling from 0.76 percent in 2002 to 0.67 percent in 2008. The travel card, by contrast, represents a smaller percentage of budgeted spending (0.28 percent in 2008) and, since 1999, has neither gone above 0.32 percent nor below 0.26 percent of budgeted spending. At present, fleet card spending is a de minimus percentage of budgeted government spending (0.08

FIGURE 3. COMMERCIAL CARD SPENDING (IN $ BILLIONS) BY CARD TYPE (1997–2008)



Note. Adapted from U.S. General Services Administration, GSA SmartPay Performance Summary at http://www.gsa.gov/Portal/gsa/ep/contentView.do?contentType=GSA_OVERVIEW&contentId=11490. Data on fleet cards unavailable prior to 1999.

FIGURE 4. COMMERCIAL CARD SPENDING AS A PERCENTAGE OF TOTAL GOVERNMENTAL BUDGET BY CARD TYPE (1997–2008)



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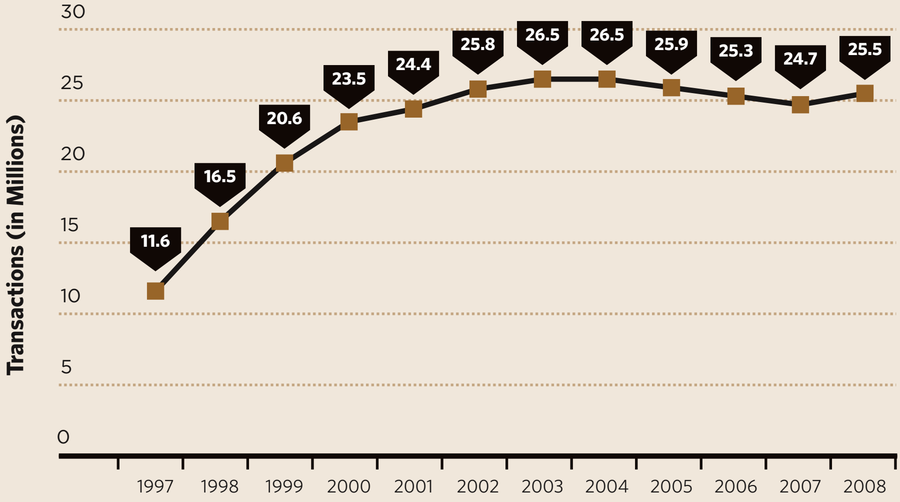
percent in 2008) that has been steadily increasing over the past 5 years. Thus, it appears that to understand commercial card spending performance by the U.S. Government, one must examine purchase card spending in greater detail given that it is the most significant component of commercial card spending over the past 11 years.

PURCHASE CARD USE BY GOVERNMENT

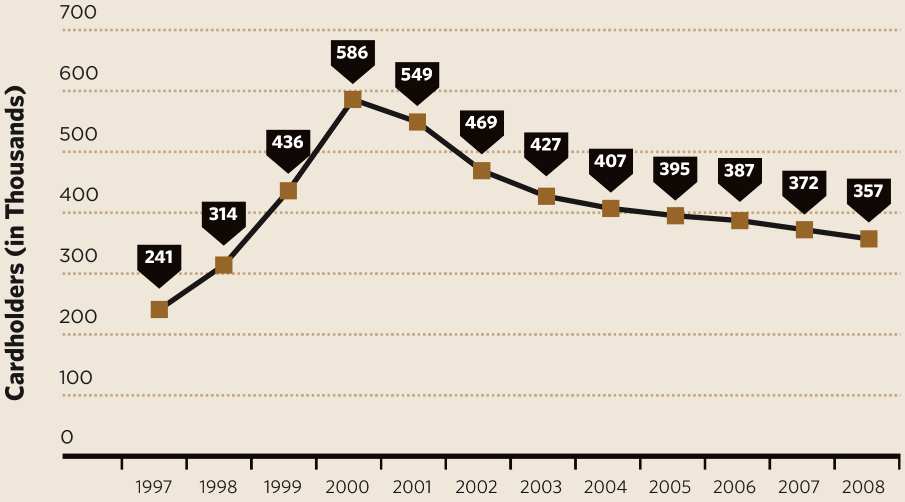
While the absolute total dollar value of purchase card spending by the U.S. Government has grown steadily since the card was adopted in the early 1990s (Figure 3), the number of transactions paid by the purchase card has been flat or declining since 2002. Figure 5 shows that 25.8 million transactions were paid for with a purchase card in 2002. By 2008, that number had declined to 25.5 million. The seemingly contradictory directions of spending and transactions are reconciled by the fact that the average transaction amount for government purchase card purchases continues to climb. In 1997, the average purchase card transaction amount was $436; by 2008, the average transaction amount was $779. This phenomenon will be discussed in more detail later in this article. Finally, the number of purchase cards held by government employees has changed over time. Figure 6

FIGURE 5. PURCHASE CARD TRANSACTIONS BY U.S. GOVERNMENT (1997–2008)



Note. Adapted from U.S. General Services Administration, GSA SmartPay Performance Summary at http://www.gsa.gov/Portal/gsa/ep/contentView.do?contentType=GSA_OVERVIEW&contentId=11490.

FIGURE 6. U.S. GOVERNMENT PURCHASE CARDHOLDERS (1997–2008)



Note. Adapted from U.S. General Services Administration, GSA SmartPay Performance Summary at http://www.gsa.gov/Portal/gsa/ep/contentView.do?contentType=GSA_OVERVIEW&contentId=11490.

shows that the number of purchase cards in the hands of government employees increased steadily from 1997 until it reached a high point of 586,000 in 2000; thereafter, the number of purchase cardholders has fallen steadily to its 2008 level of 357,000.

TRENDS IN MILITARY AND CIVILIAN USE OF PURCHASE CARDS

The use of purchase cards can vary widely by type of federal agency. The most fundamental distinction between federal agencies is their character or orientation—civilian or military. As shown in Figures 7, 8, and 9, the military (Army, Air Force, Navy, and Department of Defense-Other) accounted for 42 percent of all government purchase card spending ($8.4 billion), 37 percent of all government purchase card transactions (9.4 million), and 31 percent of all government purchase cardholders (109,000) in 2008, respectively.

Figures 8 and 9 also reveal unique trends that separate military from civilian agency use of the purchase cards. Figure 8 reflects that purchase card transactions by the military more than doubled between 1997 and 2002, going from 5.0 million to 11.0 million. However, since 2002, military purchase card transactions have steadily declined to 9.4 million in 2008. Civilian agency purchase card transactions also more than doubled between 1997 and 2002 (going from 6.6 million to 14.8 million). Yet, unlike the military,

FIGURE 7. TOTAL PURCHASE CARD SPENDING BY CIVILIAN AND MILITARY AGENCIES (1997–2008)

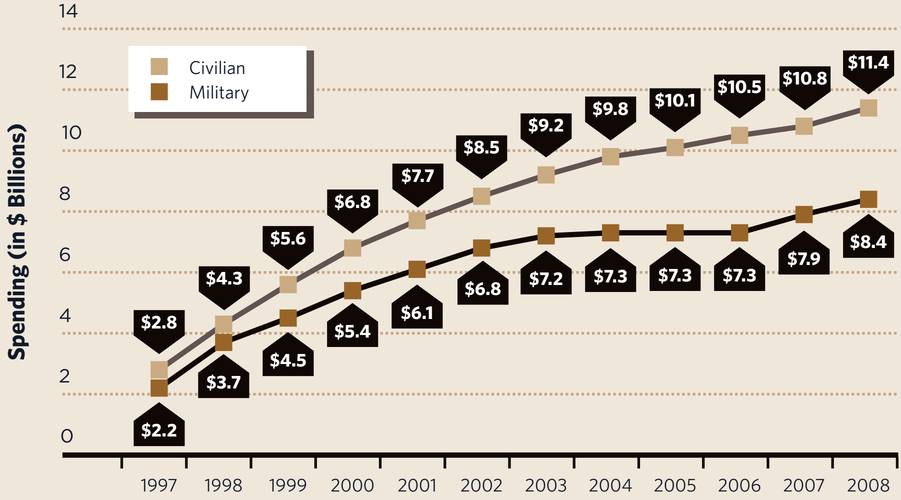


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FIGURE 8. TOTAL PURCHASE CARD TRANSACTIONS BY CIVILIAN AND MILITARY AGENCIES (1997–2008)

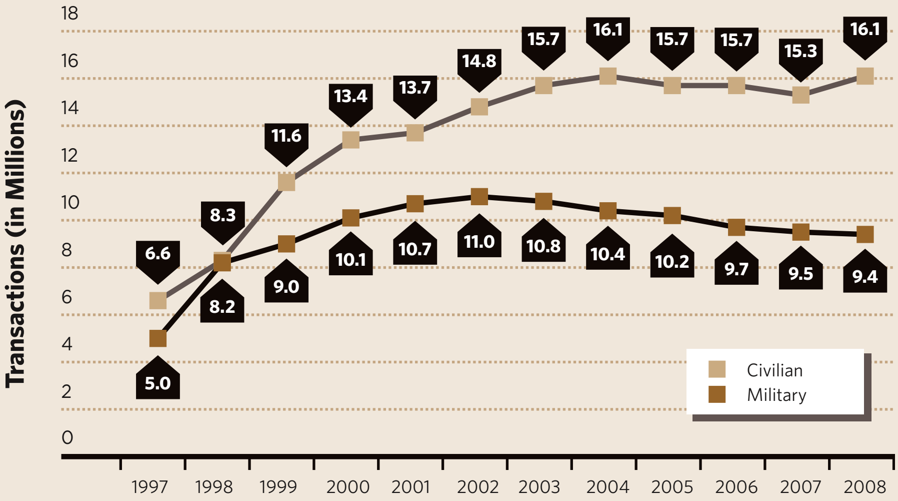

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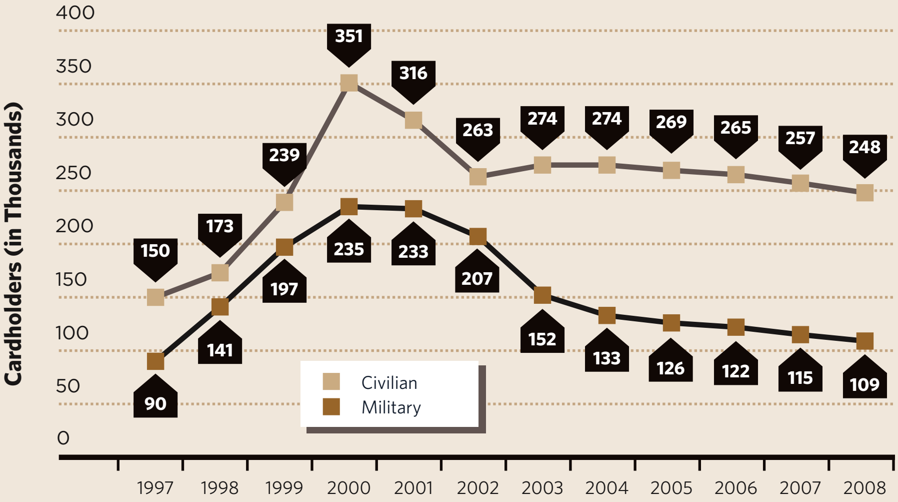
FIGURE 9. TOTAL PURCHASE CARDHOLDERS BY CIVILIAN AND MILITARY AGENCIES (1997–2008)



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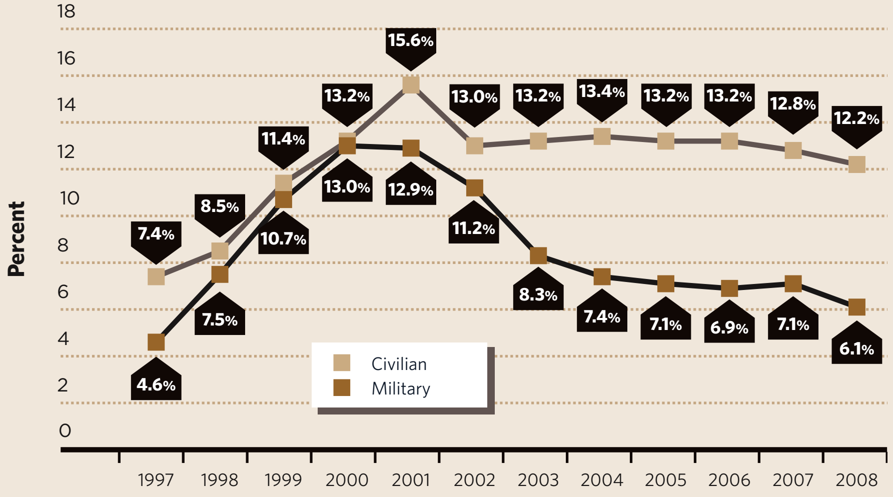
civilian agency purchase card transactions continued upward to a plateau of 16.1 million in 2004, a figure that is the same as that reported in 2008.

Further, trends in card distribution differ between military and civilian agencies. Figure 9 shows that, while both military and civilian agencies rapidly expanded the number of purchase cards given to employees between 1997 and 2000, thereafter the military reduced the number of cardholders at a more aggressive rate than its civilian counterparts. Specifically, Figure 9 shows that the military reduced the number of cardholders from 235,000 in 2000 to 109,000 in 2008—a 54 percent decline. Civilian agencies, by contrast, cut the number of purchase cardholders from 351,000 in 2000 to 248,000 in 2008—a 29 percent decline. Figure 10 puts the purchase card distribution practices into context, showing the percentage of employees provided purchase cards within civilian and military agencies. The percentage of civilian agency employees given purchase cards (Figure 10) has held reasonably steady since 2002 (around 12 percent to 13 percent), while the percentage of military agency employees given purchase cards has fallen steadily from 13.0 percent in 2000 to 6.1 percent in 2008.

FIGURE 10. PURCHASE CARD DISTRIBUTION BY MILITARY AND CIVILIAN AGENCIES (1997–2008)

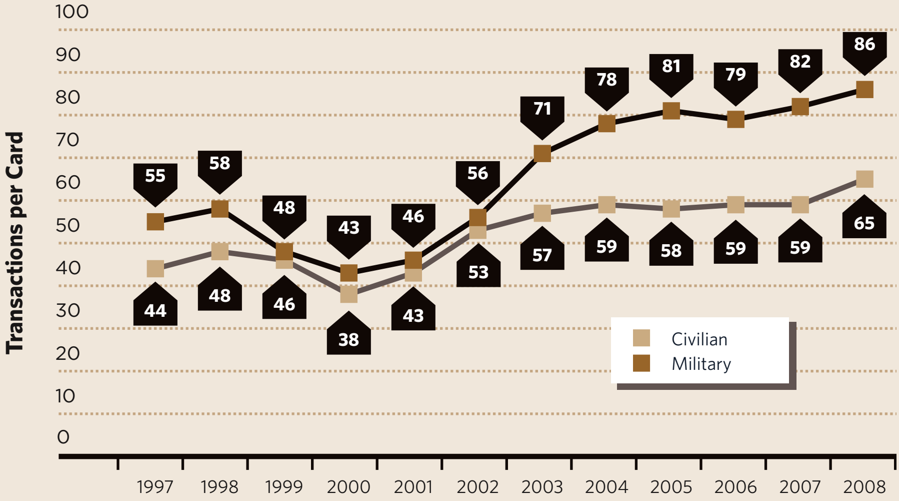


Note. Adapted from agency headcount data found in Federal Civilian Workforce Statistics: Employment and Trends (as of March in each year). Military headcount data found in the Active Duty Military Personnel Strengths by Regional Area and by Country (309A), Department of Defense at http://web1.whs.osd.mil/mmid/military/history/309hist.htm). Cards distributed are provided by the U.S. General Services Administration, GSA SmartPay Performance Summary at http://www.gsa.gov/Portal/gsa/ep/contentView.do?contentType=GSA_OVERVIEW&contentId=11490.

Reconciling Spending Patterns at Military Agencies

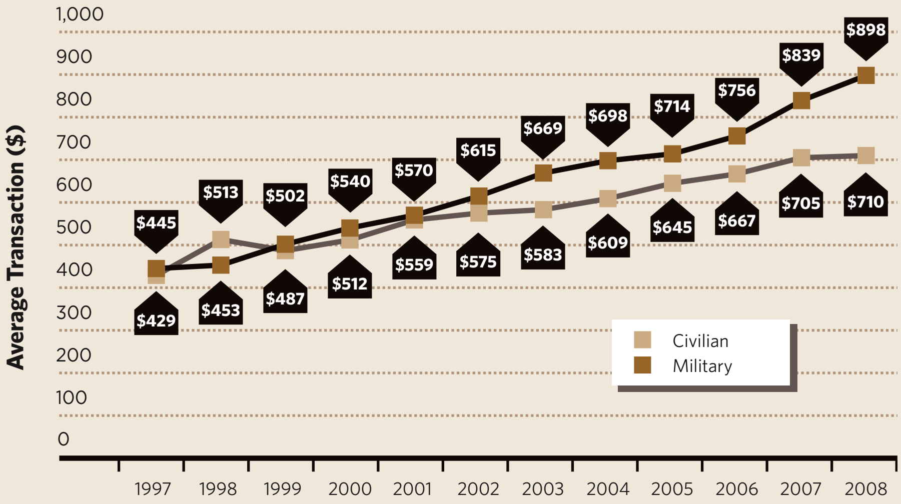
Figures 11 and 12 help to explain how military spending continues its upward trajectory while its card distribution and the number of card transactions continue to decline. Specifically, Figure 11 compares the annual number of transactions per card at military and civilian agencies. Between 1997 and 2002, the number of transactions per purchase card was similar among military and civilian agencies. In 2003, a clear shift occurred in the pattern of card use that differentiates military from civilian agencies. In 2003 and beyond, the relatively fewer military purchase cardholders became more active users of the cards distributed. Thus, in 2003 we find that the average military card was used to conduct 25 percent more transactions per year than civilian cards (71 versus 57 transactions), thereby compensating in part for the significant disparity in card distribution shown in Figure 10 (13.2 percent for civilian agencies and 8.3 percent for military agencies in 2003). By 2008, the typical military purchase card was used to conduct 32 percent more transactions per year than a civilian agency card (86 versus 65 transactions).

FIGURE 11. PURCHASE CARD TRANSACTIONS PER CARD BY MILITARY AND CIVILIAN AGENCIES (1997–2008)



Note. Adapted from agency headcount data found in Federal Civilian Workforce Statistics: Employment and Trends (as of March in each year). Military headcount data found in the Active Duty Military Personnel Strengths by Regional Area and by Country (309A), Department of Defense at http://web1.whs.osd.mil/mmid/military/history/309hist.htm). Cards distributed are provided by the U.S. General Services Administration, GSA SmartPay Performance Summary at http://www.gsa.gov/Portal/gsa/ep/contentView.do?contentType=GSA_OVERVIEW&contentId=11490.

FIGURE 12. AVERAGE PURCHASE CARD TRANSACTION AMOUNT BY MILITARY AND CIVILIAN AGENCIES (1997–2008)



Note. Adapted from U.S. General Services Administration, GSA SmartPay Performance Summary at http://www.gsa.gov/Portal/gsa/ep/contentView.do?contentType=GSA_OVERVIEW&contentId=11490.

As with transaction activity on cards distributed, a clear shift also occurred in the average transaction amount in 2003 that also differentiates military and civilian agencies. In 2003, the average military transaction amount was $669—a figure 15 percent higher than the average transaction amount of civilian agencies ($583). By 2008, the average transaction amount for the military had risen to $898—a figure 26 percent higher than civilian counterparts ($710). Thus, it appears that declining card distribution among military agencies has been at least partially offset by increasing card activity, both in terms of the number of purchase transactions and the amount of goods acquired when a purchase is made.

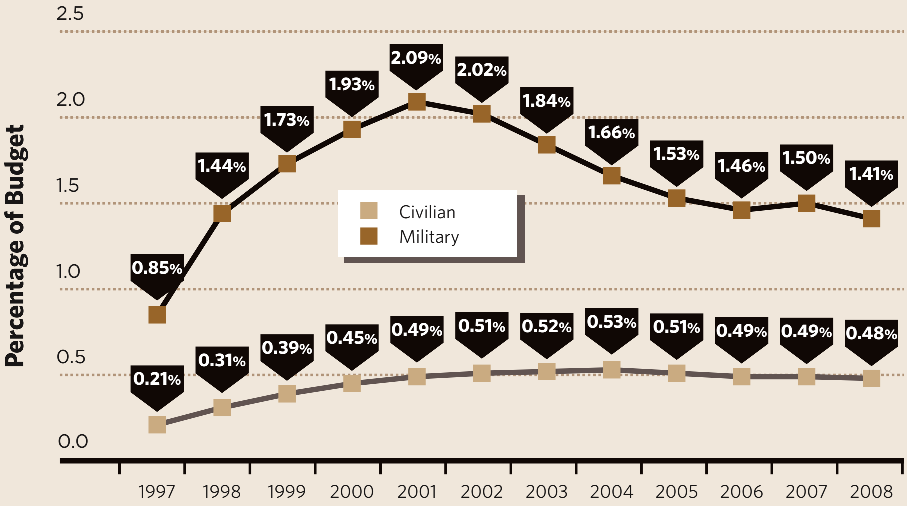
Summarizing the Differences and their Impact on Government Card Program Performance

The U.S. Government recognized the potential benefit of purchase card use as far back as 1982 and has reaffirmed its value to operations through many administrations (see a brief history of government purchase cards contained in Palmer & Gupta, 2007a). The best estimate of government cost savings from driving a paper-based approval and payment process to a purchase card is $69 per transaction, based on the card's ability to reduce or eliminate the time needed to process requisitions, purchase orders, invoices, and payments (Palmer & Gupta, 2007b, pp. 24–31). Thus, the higher the number of transactions driven to the purchase card, the greater the cost savings to the government. Each government agency is responsible for developing its own guidelines for the appropriate use of purchase cards, which presumably also reflect the agency strategy for extracting the most benefits of purchase card use (Office of Management and Budget, 2009).

Figure 13 summarizes the performance of military and civilian purchase card program strategies as measured against a key evaluative metric—purchase card spending as a percent of total budgeted spending. Figure 13 shows that the military has asserted a strong leadership role in governmental use of card technology. Specifically, military purchase card spending as a percentage of military budget has been and remains notably higher than its civilian counterparts. As of 2008, purchase card spending as a percent of budget by the military is nearly three times higher than civilian agencies (1.41 percent versus 0.48 percent).[1]

Figure 13 also illustrates important diverging trends between military and civilian purchase card use. For example, both the military and civilian agencies more than doubled their purchase card spending as a percent of budgeted spending in the 1997 to 2001 timeframe. The military (civilian) agencies increased purchase card spending as a percent of budgeted spending from 0.85 percent (0.21 percent) in 1997 to 2.09 percent (0.49

FIGURE 13. PURCHASE CARD SPENDING AS A PERCENTAGE OF BUDGET BY MILITARY AND CIVILIAN AGENCIES (1997–2008)



Note. Adapted from federal budget data found in the Final Monthly Treasury Statements of Receipts and Outlays of the United States Government, Department of the Treasury Financial Management Service. Commercial card spending data available at GSA SmartPay Performance Summary at http://www.gsa.gov/Portal/gsa/ep/contentView.do?contentType=GSA_OVERVIEW&contentId=11490.

percent) in 2001. However, since 2001, the military and civilian agencies have taken different paths. Military purchase card spending as a percent of budgeted military spending decreased in a fairly regular manner from 2.09 percent in 2001 to 1.41 percent in 2008. By contrast, civilian agency purchase card spending as a percent of budgeted spending has remained fairly constant since 2001 (around 0.50 percent of budgeted spending).

The downward trend in military purchase card spending in relation to the military budget has had a significant impact on the success of the overall government purchase card and commercial card programs. Figure 14 shows that if the military had held steady at its 2001 level of purchase card spending in relation to its budget (2.09 percent), total government purchase card spending would have increased by $4.1 billion (from $19.8 billion to $23.9 billion in 2008). Or, if the military could have achieved and held steady at the 2001 Army level of purchase card spending as a percent of budget (3.40 percent), total government purchase card spending in 2008 would have been $11.9 billion higher ($31.7 billion instead of $19.8 billion). Assuming an average transaction amount of $898 (the 2008 military norm), this would mean that potentially 13.22 million additional transactions could have been shifted to purchase cards, leading to additional administrative cost savings of $912 million (assuming $69 per transaction cost savings discussed earlier) for 2008 alone. Figure 15 provides the actual and potential cost savings (at $69 per transaction) since 2001 if the military had continued to capture a higher percentage of its budget (either 2.09 percent or 3.40 percent) on purchase cards. Figure 15 indicates that, cumulatively, over $5.4 billion in administrative

FIGURE 14. ACTUAL AND PROJECTED GOVERNMENT PURCHASE CARD SPENDING IF MILITARY PURCHASE CARD SPENDING HAD HELD CONSTANT AS A PERCENT OF BUDGET SINCE 2001

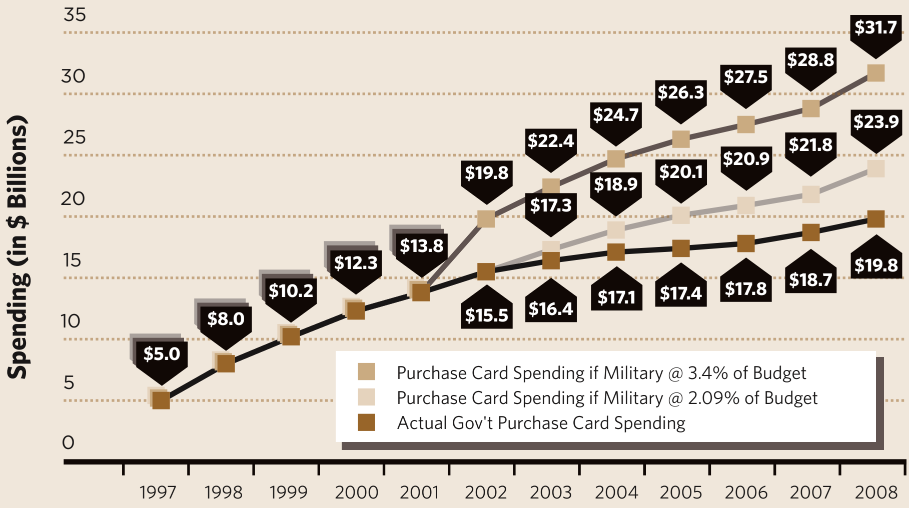
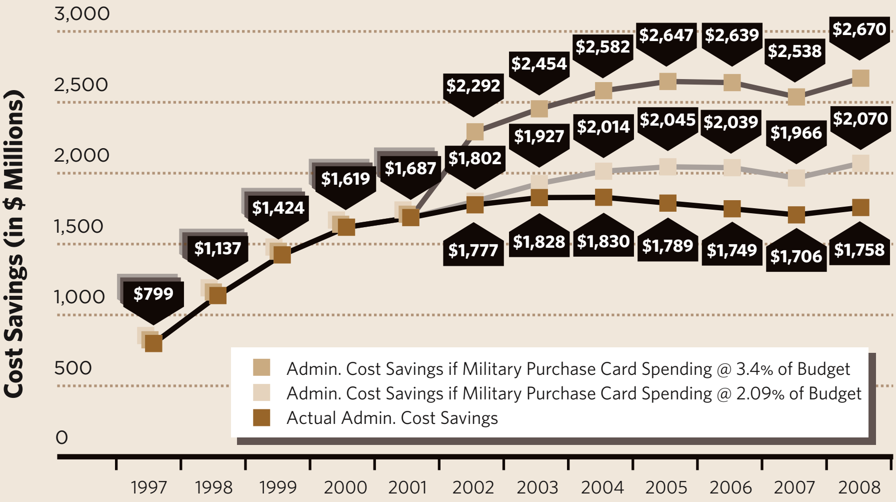


FIGURE 15. ESTIMATED ADMINISTRATIVE COST SAVINGS (IN $ MILLIONS) BASED ON ACTUAL AND PROJECTED GOVERNMENT PURCHASE CARD SPENDING IF MILITARY PURCHASE CARD SPENDING HAD HELD CONSTANT AS A PERCENT OF BUDGET SINCE 2001



cost savings could have been generated in the 2002–2008 time period had the military achieved and maintained purchase card spending at the Army 2001 level of 3.4 percent of budgeted spending.

Further, reduced purchase card use also diminishes direct cost savings in the form of refunds from card issuers and improved cash management practices such as petty cash requirements and float opportunities (AGA, 2006). Approximately $26 million in rebate revenue is potentially lost because of the drop in military purchase card spending from 2.09 percent to 1.41 percent of its budget (Federal News Radio, 2009).[2] Other potential benefits lost relate to the value of consolidated data supporting vendor discounts and indirect cost savings from reduced cycle time for purchases.[3]

Identifying Potential Root Causes of Reduced Purchase Card Distribution

The military changed its strategy with respect to the distribution and use of purchase cards on or about FY 2002. At that time, the military significantly reduced purchase card distribution, putting purchase cards in the hands of fewer people who were specifically tasked to serve as buyers for others in their units.[4] This explains both the increased transaction activity and higher average transaction amounts on the fewer cards distributed. While this strategy succeeded in reducing card distribution, it appears (based on continuing declines in purchase card spending as a percent of budgeted spending) that many low-value purchases might be funneled through other procurement processes to fulfillment within the military. If these routes are nonelectronic and labor-intensive, the cost to the government to process these transactions is significant.

A variety of possible explanations exists for the change in military purchase card use. First, the military may be shifting a greater number of its potentially "cardable" transactions to other forms of electronic payment. However, we could not find any published report indicating that this has transpired.

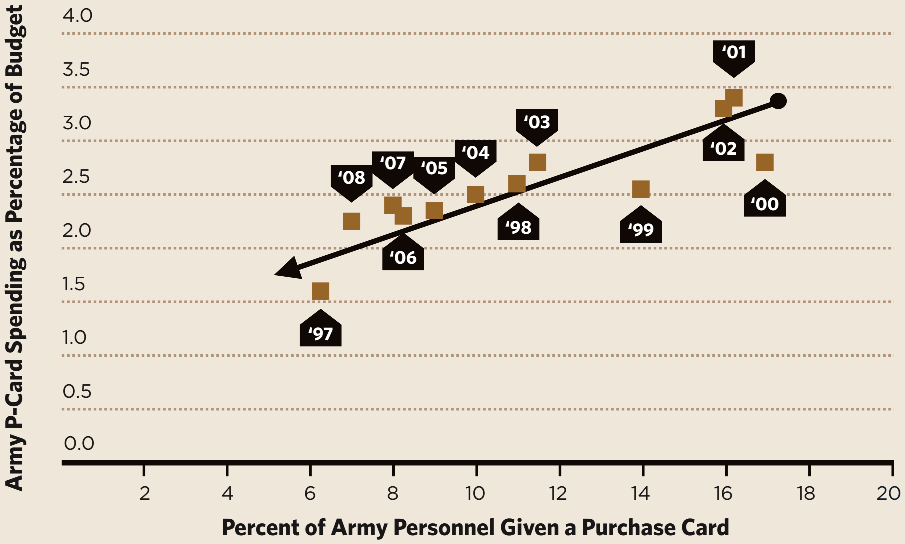
The second possible explanation for the shift in military purchase card use is change in the nature of military purchases. Ongoing military operations overseas may have pushed military budgets outside of their normal parameters and account for a portion of the changes in purchase card spending patterns, including a possible reduction in cardable transactions.

The third and most likely explanation for the military's change in purchase card use and purchase card program configuration has to do with military response to then-General Accounting Office (GAO) audit findings of incidents of military purchase card fraud, waste, and abuse (GAO, 2001a, 2001b, 2001c, 2001d; GAO, 2002c, 2002d, 2002e). These findings criticized several military purchase card programs for a variety of inadequacies related to the control over spending, including inadequate allocation of resources to manage programs, lack of supporting documentation, split purchases, inadequate accounting for asset acquisitions, lack of cardholder and approving official training, purchases made from "nonpreferential" sources, and lack of timely reconciliation and spending activity to card charges.

In response to the GAO findings, the Army (GAO, 2003a) and Navy (GAO, 2002b) stated plans to reduce the number of purchase cards in their organizations. The Air Force, subject to a similarly unflattering report of purchase card program mismanagement (GAO, 2002a), issued a formal policy memo in March 2003 directing that the number of cards issued should be minimized, and took steps to tighten card spending limits and deactivate purchase cards where cardholders violate policy (GAO, 2003a). In 2002, the Office of Management and Budget also required agencies to review the need for the number of purchase cards then in circulation, and reduce the number where appropriate (Styles, 2002). As shown earlier in Figure 10, the extent of these almost continuous GAO and Department of Defense Inspector General audits had a chilling effect on the distribution of purchase cards in the military agencies, with the percentage of military purchase cardholders dropping steadily at all military agencies since 2001. It is interesting and important to note that the GAO criticisms were directed at civilian agencies as well, though the pullback in card distribution at those agencies did not occur on the same scale.[5]

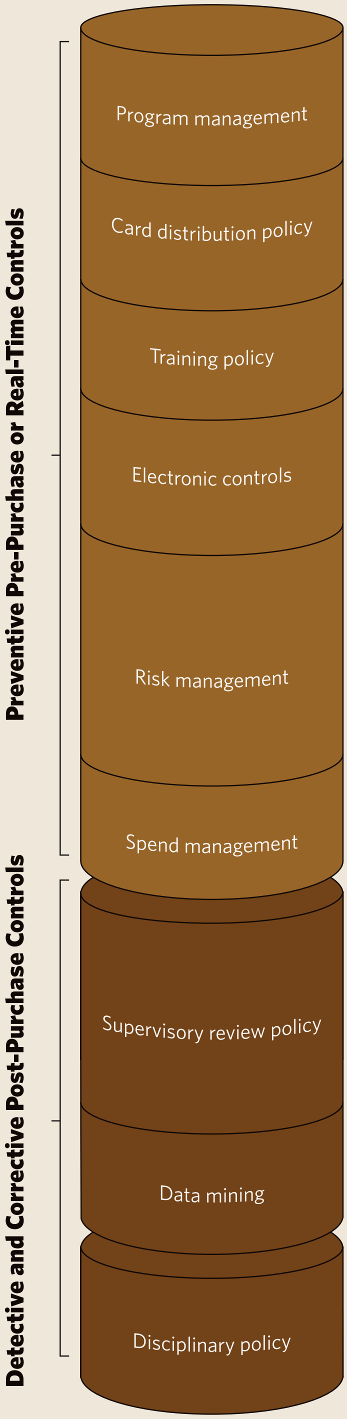
Unfortunately, the benefits that can be derived from purchase cards (reduced manpower to process paperwork, reduced purchase cycle times, etc.) require purchase card use, which is closely tied to purchase card access. Figure 16 provides an example of the relationship between card distribution and purchase card spending as a percent of organizational budget in a military context, e.g., the Army, which accounts for over half of all military purchase card spending. As shown in Figure 16, the Army reported its highest purchase card spending as a percent of budget in those years with the highest levels of purchase card distribution across its employee base. Further, Figure 16 reflects a distinct trend: As the Army decreased the percentage of personnel to whom it provided purchase cards, it experienced a concomitant decline in the "capture" of budgeted spending on the purchase card.

FIGURE 16. ARMY CARD DISTRIBUTION AND PURCHASE CARD SPENDING AS A PERCENT OF BUDGET SPENDING (1997–2008)



Note. Adapted from federal budget data found in the Final Monthly Treasury Statements of Receipts and Outlays of the United States Government, Department of the Treasury Financial Management Service. Commercial card spending and card distribution data available at GSA SmartPay Performance Summary at http://www.usaspending.gov/pcard/index.php?reptype=a. Agency headcount data found in Federal Civilian Workforce Statistics: Employment and Trends (as of March in each year). Military headcount data found in the Active Duty Military Personnel Strengths by Regional Area and by Country (309A), Department of Defense, at http://web1.whs.osd.mil/mmid/military/history/309hist.htm.

FIGURE 17. A CONTROL MODEL FOR CARD-BASED PAYMENTS



	Description of Control
Program management	Provide resources sufficient to support card program. Define duties and responsibilities. Link to job performance ratings. Resolve hierarchical conflicts to ensure a process to address card misuse by top management (if any).
Card distribution policy	Develop policies relating to card distribution, including the criteria for individuals who are given a card (the appropriate percentage of employees or types of employees to be given cards).
Training policy	Establish requirements and methods (e.g., in person, Internet-based) for initial and refresher training for cardholders, approving officials, and administrators.
Electronic controls	Put in place controls that are electronically enforced per transaction controls, monthly spending limits controls, merchant category code blocking, split purchase controls, cardholder spending profiles, etc.
Risk management	Implement steps to manage financial risk associated with cards including (a) setting spending limits appropriate to purchase activity, (b) deactivating minimally used or unused accounts, (c) barring approving officials from possessing a card, (d) using "disappearing accounts" for projects, grants, trips, or specific purchases, and (e) obtaining card issuer-provided insurance related to fraudulent card use.
Spend management	Develop policy and procedures to ensure that preferred suppliers are used for specific types of purchases and mechanisms exist (preferably electronic) to ensure applicable discounts are obtained.
Supervisory review policy	Develop policies that ensure a comprehensive review of cardholder spending such as (a) formal evaluation of the reviewer's evaluation of subordinate spending, (b) capping the number of cardholders to be reviewed by one approving official, and (c) establishing and monitoring a process ensuring examinations of "decline authorizations" and disputed transactions.
Data mining	Leverage the capabilities of electronic identification of unusual spending patterns, including purchases (a) at unusual times or dates, (b) from unusual vendors or merchant category codes, or (c) in unusual circumstances.
Disciplinary policy	Develop policies and take disciplinary actions to preclude and guard against inappropriate and fraudulent card use, including terminations, employee record documenting, card removal, or card spending limit reduction.

Note. Adapted from Palmer & Gupta (2007c).

Is the Military Response Still Appropriate?

By implementing policies and practices to reduce the number of purchase cards (rather than relying on other actions to enhance control and oversight over program activities), the military has reduced the benefits available by card use.[6] Worthy of note is that during the same timeframe, civilian agencies did not exactly follow the DoD example and have not experienced declines in key metrics of their purchase card program performance. Given changes in purchase card controls and improvements in card technology since the turn of the century, it may be an appropriate time to revisit current card distribution practices across military agencies. Purchase card control models (such as the one shown in Figure 17) now reflect multiple layers of available spending controls tested across a wide range of organizations (both in government and in the private sector) and supported by ongoing changes in card technology. Further, card issuers and software developers have significantly upgraded the capabilities of card technology to accommodate improved information payload and advanced electronic controls such as Merchant Category Code, or MCC blocking, fraud alerts, data mining, and preauthorization requirements. Back-end improvements in technology now also support online statement review, approval, and certification. In addition, advances such as electronic accounts payable cards, virtual cards, and one-time-use cards enable an organization to maintain many legacy process controls while shifting the actual payment to the card, generating additional benefits for card users both in the government and private sector.

Conclusions

The purpose of this article was to examine the potential causes for the slowdown of the transition from traditional purchasing processes for low-value goods to commercial, card-based payment tools by U.S. Government agencies, and to recommend possible options to correct them. Because the military is the largest component of government commercial card use, special attention was given to its role in the card use trends. The analysis showed that the downward trend in military use of commercial cards is responsible for the reduced pace of U.S. Government commercial card spending and, potentially, costs of as much as $1 billion per year in unnecessary administrative transaction processing costs and lost rebates. Specifically, reduced card distribution by military agencies since 2002 appears to be the single most important reason for the slowdown of transition of low-dollar transactions to U.S. Government commercial cards. It may be the appropriate time for the military to reconsider its purchase card distribution policies and practices to fully capture the cost-savings benefits to the government from card use.

A re-evaluation of commercial card policies and practices by the military at this juncture (with increasing economic constraints) would be particularly advantageous, inasmuch as card issuers and third-party software firms now offer more alternatives and better control tools to manage and support card programs. Card issuers have been aggressively upgrading the capabilities of commercial card technology to accommodate improved information payload and advanced electronic controls such as data mining, fraud alerts, and preauthorization requirements. Back-end improvements in technology now also support online statement review, approval, and certification. In addition, advances such as one-time use "accounts payable" or "e-payables" cards enable an organization to maintain many legacy process controls while shifting the actual payment to the card, generating additional benefits for the government. The ability of the U.S. Government commercial card program to deliver the maximum benefits expected and available through card use requires this re-examination.

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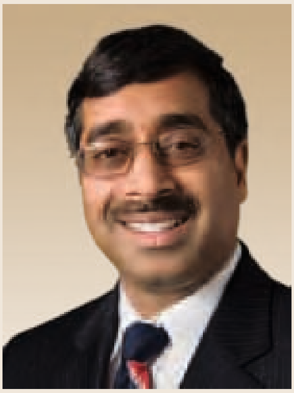

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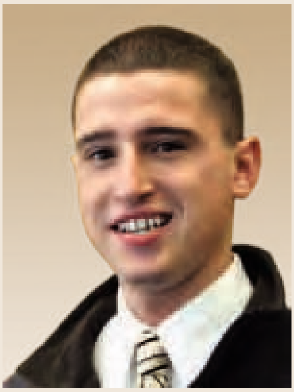

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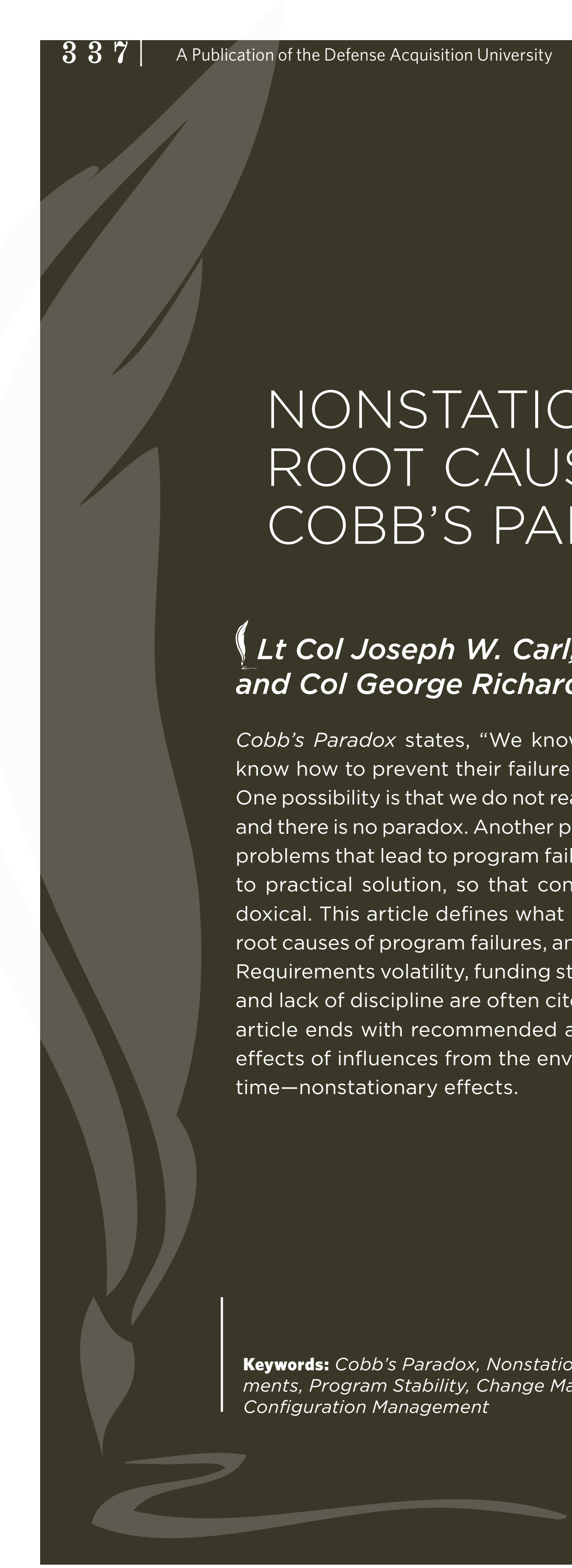
ENDNOTES

1. The civilian agency average is 0.78 percent when agencies with a high percentage of mandated spending (such as Health and Human Services, Social Security, etc.) are removed.
2. In Fiscal Year 2008 alone, the Federal Government received $190 million of rebates on $30.6 billion of spending (Federal News Radio, 2009). Thus, at this level of refund (0.63 percent of spending), the $4.1 billion of higher government spending that would have occurred if the military were able to maintain its purchase card spending at 2.09 percent of its budget, would have yielded an additional $26 million in rebates.
3. The GSA SmartPay Performance Report is available at http://www.gsa.gov/gsa/cm_attachments/GSA_DOCUMENT/ExecutiveSummary_R2FIAJ_0Z5RDZ-i34K-pR.doc
4. Interestingly, we examined each military branch and found remarkably similar patterns, particularly with respect to the shrinking number of purchase cardholders.
5. See, for example, GAO purchase card audits of the Forest Service (GAO, 2003b), HUD (GAO, 2003c), and FAA (2003d).
6. While the OMB prescribes policies and procedures to agencies regarding how to maintain internal controls, those prescriptions do not include a specification of the extent of card distribution within the agency. The Under Secretary of Defense for Acquisition, Technology, and Logistics, in cooperation with the Under Secretary of Defense (Comptroller)/Chief Financial Officer, and the DoD Purchase Card Joint Program Management Office, are responsible for the DoD purchase card program.



NONSTATIONARY ROOT CAUSES OF COBB'S PARADOX

Lt Col Joseph W. Carl, USAF (Ret.)
and Col George Richard Freeman, USAFR (Ret.)

Cobb's Paradox states, "We know why [programs] fail; we know how to prevent their failure—so why do they still fail?" One possibility is that we do not really know why programs fail and there is no paradox. Another possibility is that some of the problems that lead to program failure may not be susceptible to practical solution, so that continued failure is not paradoxical. This article defines what we mean by nonstationary root causes of program failures, and identifies 10 such causes. Requirements volatility, funding stability, process immaturity, and lack of discipline are often cited among the reasons. The article ends with recommended approaches to mitigate the effects of influences from the environment that change over time—nonstationary effects.

Keywords: *Cobb's Paradox, Nonstationary Environments, Program Stability, Change Management, Configuration Management*

image designed by Miracle Riese »

In 2007, the many examples of government project failures led then-Under Secretary of Defense for Acquisition, Technology and Logistics John Young to issue a memorandum that requires prototyping and competition on all major programs up to Milestone B (Young, 2007). Young's memorandum was a propitious start. But is it likely to be sufficient to solve all the problems that lead to project failure?

This article summarizes the number and spectrum of project failures, and makes the case that project failures cannot be attributed solely to mismanagement on the part of project managers. Rather, it appears improbable that all project managers of large complex projects could produce similar failures. The prevailing perception throughout the acquisition community is that program and project managers know why projects fail and how to prevent them from failing. The authors discuss the concept of other influences from the environment that change over time—nonstationary effects—that may be the root cause of these numerous project failures.

Background

In 2006, a Government Accountability Office report (GAO, 2006) highlighted several government project failures.

> In the last 5 years, the Department of Defense (DoD) has doubled its planned investments in new weapon systems from about $700 billion in 2001 to nearly $1.4 trillion in 2006. While the weapons that DoD develops have no rival in superiority, weapon systems acquisition remains a long-standing, high-risk area. GAO's reviews over the past 30 years have found consistent problems with weapon acquisitions such as cost increases, schedule delays, and performance shortfalls.

The report goes on to state that this huge increase in spending over the past 5 years "has not been accompanied by more stability, better outcomes, or more buying power for the acquisition dollar." Examples of this huge increase in spending follow:

- Capable satellites, potential overrun of $1.4 billion
- Satellite payload cost and schedule overruns greater than $1.1 billion
- Radar contract projected to overrun target cost by up to 34 percent
- Advanced Precision Kill Weapon System (Joint Attack Munition Systems), curtailment of initial program in January 2005 due to development cost overruns, projected schedule

slip of 1–2 years, unsatisfactory contract performance, and environmental issues

- C-5 Avionics Modernization Program, $23 million cost overrun
- C-5 Reliability Enhancement and Re-engineering Program, $209 million overrun
- F-22A, increase in the costs of avionics since 1997 by more than $951 million or 24 percent, and other problems discovered late in the program.

On March 31, 2006, Comptroller General of the United States David M. Walker stated in congressional testimony:

> The cost of developing a weapon system continues to often exceed estimates by approximately 30 percent to 40 percent. This in turn results in fewer quantities, missed deadlines, and performance shortfalls. In short, the buying power of the weapon system investment dollar is reduced, the warfighter gets less than promised, and opportunities to make other investments are lost. This is not to say that the nation does not get superior weapons in the end, but that at twice the level of investment. DoD has an obligation to get better results. In the larger context, DoD needs to make changes…consistent with getting the desired outcomes from the acquisition process.

Cobb's Paradox

In 1995, Martin Cobb worked for the Secretariat of the Treasury Board of Canada. He attended The Standish Group's CHAOS University, where the year's 10 most complex information technology (IT) projects are analyzed and discussed. The 10 most complex IT projects studied by The Standish Group in 1994 were all in trouble: eight were over schedule, on average by a factor of 1.6 and over budget by a factor of 1.9; the other two were cancelled and never delivered anything. That led Cobb to state his now-famous paradox (Cobb, 1995): "We know why [programs] fail; we know how to prevent their failure—so why do they still fail?"

The Standish Group uses project success criteria from surveyed IT managers to create a success-potential chart. The success criteria are shown in the Table, where they are ranked according to their perceived importance. There seems to be an assumption that all the criteria are stationary—that they are assumed to be present on any specific project to some degree and do not change over time except potentially for the better with conscious effort. A little more formally, a process or system is said to be stationary if its behavioral description does not change over time, and nonstationary if its behavioral description does change over time.

TABLE. CRITERIA USED BY THE STANDISH GROUP TO GAUGE THE CHANCE OF PROJECT SUCCESS

Success Criteria
1. User Involvement
2. Executive Management Support
3. Clear Statement of Requirements
4. Proper Planning
5. Realistic Expectations
6. Smaller Project Milestones
7. Competent Staff
8. Ownership
9. Clear Vision & Objectives
10. Hardworking, Focused Staff

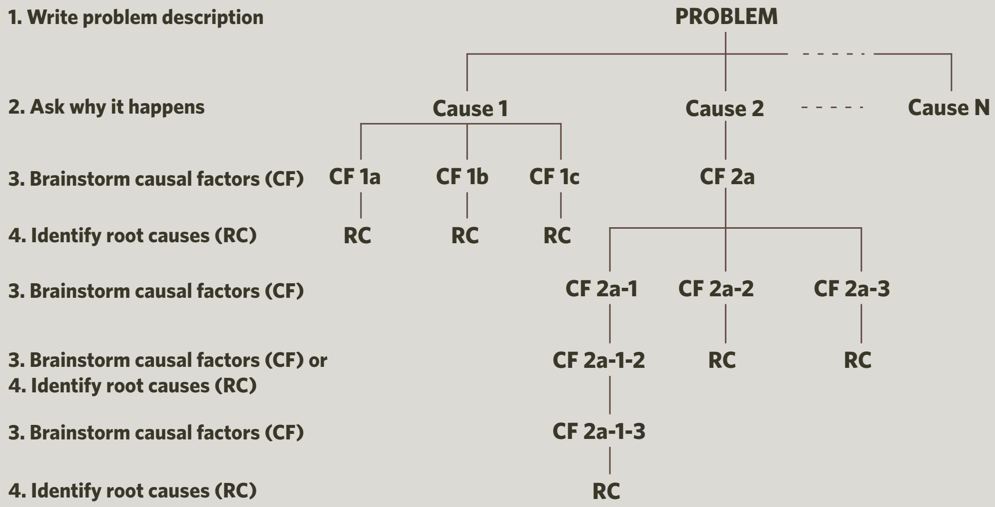
Systems under development exist in an environment that is not at all stationary over a project's development span. Technology changes in significant ways. Leaders retire or are replaced, and new leaders have new priorities and perceptions. New threats emerge and old threats diminish. Marketplaces shift as consumers change their buying habits in response to advertising and personal needs. Nonstationary environmental factors prevent requirements from being established early with the thought that they will not change. They will certainly change independent of the degree of discipline and process maturity on the part of the system developer.

The Five Whys

"A poorly defined problem and a rush to solution and action lead to activity without achieving the desired results" (Liker & Meier, 2006, p. 327). One recognized technique for defining problems and uncovering root causes of problems is to ask the *five whys*. Toyota refers to the five-whys process as a causal chain (Figure 1) because the questions and answers are chain-linked to help keep track of them. Perhaps the best way to explain the five-whys process for those not already familiar with the technique is to demonstrate it. The basic idea is to ask why about five times. The criteria from the Table suggest the causal factors that we can further explore to arrive at root causes of project failures.

So let's begin by defining the problem: *to discover why projects fail*. A possible first primary cause answer is: *because requirements change over*

FIGURE 1. CRITERIA USED BY THE STANDISH GROUP

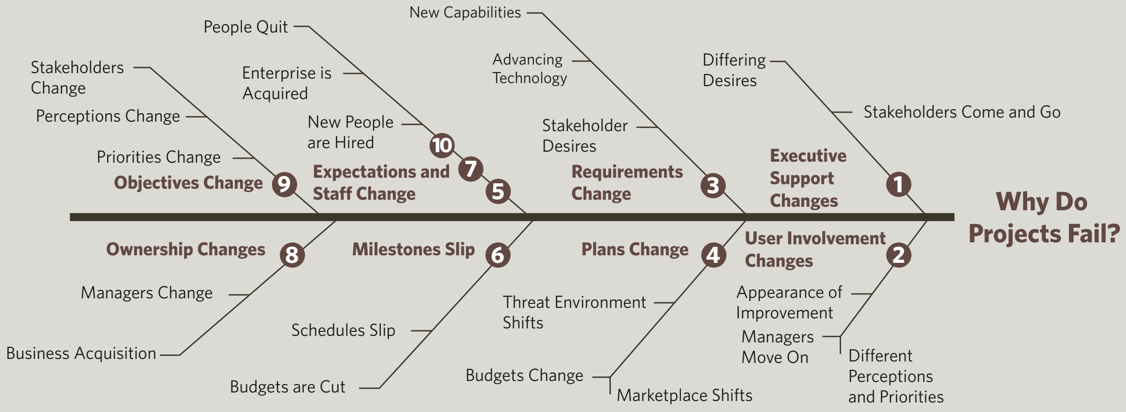

1. Write problem description
PROBLEM
2. Ask why it happens
Cause 1
Cause 2
Cause N
3. Brainstorm causal factors (CF)
CF 1a
CF 1b
CF 1c
CF 2a
4. Identify root causes (RC)
RC
RC
RC
3. Brainstorm causal factors (CF)
CF 2a-1
CF 2a-2
CF 2a-3
3. Brainstorm causal factors (CF) or
4. Identify root causes (RC)
CF 2a-1-2
RC
RC
3. Brainstorm causal factors (CF)
CF 2a-1-3
4. Identify root causes (RC)
RC

time. Then we seek causal factors with why No. 2: *Why do requirements change over time?* A possible answer is: *because advances in technology create opportunities.* Then we dig for deeper causal factors with why No. 3: *Why do advances in technology create opportunities?* A possible answer is: *because Moore's Law (1965) states that the number of components on a digital chip doubles every 18 months, which means digital products become practical that weren't practical earlier.* Then we dig again for deeper causal factors, with why No. 4: *Why do digital products become practical that weren't practical earlier?* A possible answer is: *because the complexity of software in the products increases to create new capabilities that demand more raw computing capacity and memory than earlier.* Then we seek the root cause with why No. 5: *Why does the increased complexity of software create new kinds of capabilities and create opportunities?* A possible answer is: *because stakeholders express a desire for new capabilities, and more complex software is the way to create them in the digital world in which we live.* When we ask good questions in the five-whys process and ask them of the right people, we quickly arrive at the root causes of problems.

We can further examine why projects fail by positing a second possible first cause: because *executive management support changes over time.* Then we seek causal factors with why No. 2: *Why does executive management support change over time?* A possible answer is: *because executive managers retire or relocate.* Then we dig for deeper causal factors with why No. 3: *Why does support change if executive managers retire or relocate?* A possible answer is: *because different managers have different priorities and perceptions.* Then we dig again for still deeper causal factors with why No. 4: *Why do different priorities and perceptions change support?* A possible answer is: *because executive managers have a vested interest in* *creating at least the appearance of improvements.* Then we seek the root cause with why No. 5: *Why does improving things require different priorities and perceptions?* A possible answer might be: *because different priorities and perceptions provide the reason and justification for the improvements.* Again, we seem to have arrived at a root cause.

We can also diagram the root causes in an *Ishikawa diagram*, also called a *fishbone* diagram. Although further questions and answers are not detailed in this article, Figure 2 diagrams the results after asking the five whys for each of the 10 success criteria. Readers may wish to ask and answer the five whys to see if they achieve similar results.

FIGURE 2. AN ISHIKAWA OR “FISHBONE” DIAGRAM


People Quit
New Capabilities
Stakeholders Change
Enterprise is Acquired
Advancing Technology
Differing Desires
Perceptions Change
New People are Hired
Stakeholder Desires
Stakeholders Come and Go
Priorities Change
10
Expectations and Staff Change
7
Requirements Change
Executive Support Changes
Objectives Change
9
5
3
1
Why Do Projects Fail?
Ownership Changes
8
Milestones Slip
6
Plans Change
4
User Involvement Changes
2
Managers Change
Threat Environment Shifts
Appearance of Improvement
Schedules Slip
Managers Move On
Business Acquisition
Different Perceptions and Priorities
Budgets Change
Budgets are Cut
Marketplace Shifts

The five whys and the Ishikawa diagram indicate that some—perhaps most of the root causes of project failures—are nonstationary. For example:

- A clear statement of requirements cannot be stationary because technology advances more quickly than ever, and marketplaces or threats in the environment shift.
- Executive management support and competent staffs must change in our world of international outsourcing and transient populations.
- Stakeholders’ expectations cannot really be held constant over a project’s life cycle regardless of whether or not they are realistic because stakeholders frequently change—not as a class, but as individuals.
- Ownership cannot remain constant in a marketplace of business resizing, reorganization, and acquisition.

Obviously, eliminating the nonstationary aspects of a project's environment is not practical. Is there any way to adapt to the changes? Though not comprehensively, at least three options can be independently adopted to mitigate the effects on a project in a changing environment. Before discussing the three options that are available, we will first review the historical setting of managing a project and review the evolutionary strategies that have recently been adopted.

Working in a Nonstationary Environment

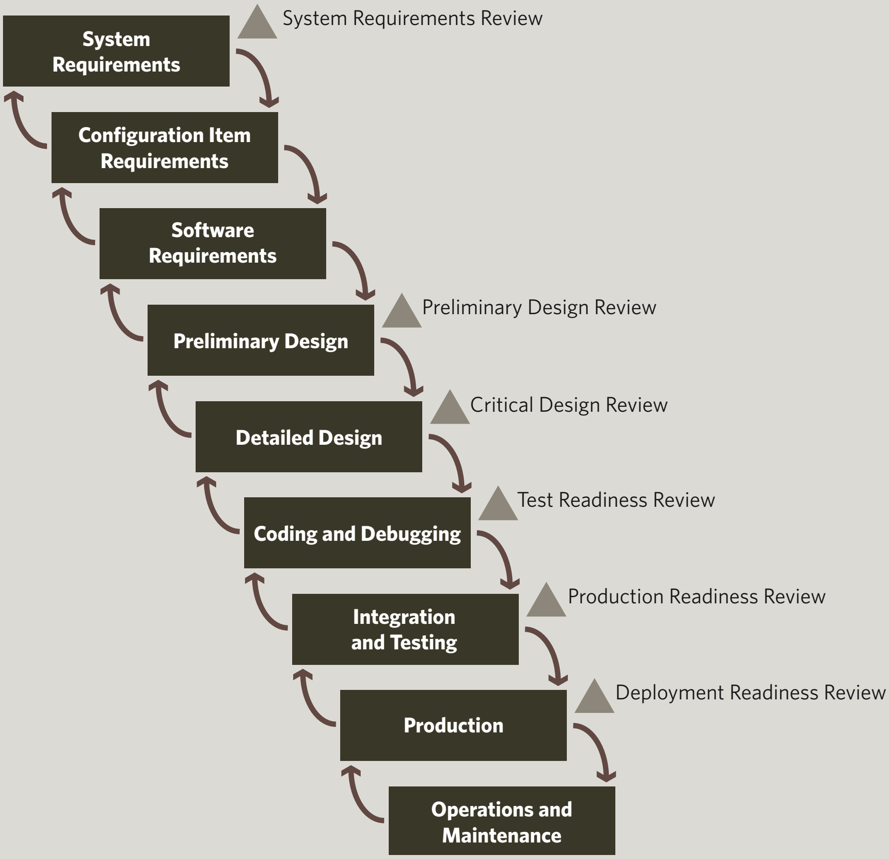
One historical method to acquire new systems is termed the *waterfall method* (Figure 3). Within the waterfall method, requirements are first established and then followed by several review milestones executed sequentially to arrive at a series of decisions that relate to the maturity of the system under design and development (Royce, 1970, pp. 1–9).

As is well known, the waterfall acquisition method can span a long time—perhaps years or even decades. The long span associated with the waterfall has been recognized as a factor in the failure of many projects that used it,[1] and this recognition led to alternative development methods such as the *spiral development method* defined by Barry Boehm (Boehm, 2002). Today there is recognition that systems evolve over their life cycles,[2] especially software systems, and the preferred approaches to system development are called evolutionary development (Pressman, 2001, pp. 34–47). Evolutionary development includes: (1) *incremental* development; (2) *spiral* development, including its win-win variations; (3) *concurrent* development; and (4) *component-based* development. For example, the Rational Unified Process (Larman, 2005) is a well-known, use-case-specified, architecture-driven, iterative software development process. The emphasis in these evolutionary development methods is on defining iterated shortened cycles that emphasize both risk reduction and increased product maturity in the subsequent repeated cycles. Evolutionary development leads to individual waterfall-like cycles that are individually short enough that the project environment is approximately stationary within the cycle.

Thus, the need to adapt to environmental changes is explicit. But this runs the risk of constant change, resulting in modification of requirements, objectives, visions, or support commitments at each cycle. Thinking of the environment as approximately constant for one cycle is not equivalent to imagining the environment is constant over the project's life cycle.

We could simply hold all requirements, visions, goals, plans, budgets, stakeholders, and staffs constant. We could view agreed-to plans as commitments, but then the risk is that we will develop systems or capabilities that are not congruent with the marketplace or threat environment; and

FIGURE 3. THE WATERFALL METHOD


System Requirements
System Requirements Review
Configuration Item Requirements
Software Requirements
Preliminary Design
Preliminary Design Review
Detailed Design
Critical Design Review
Coding and Debugging
Test Readiness Review
Integration and Testing
Production Readiness Review
Production
Deployment Readiness Review
Operations and Maintenance

that would be like Ford creating an Edsel without paying attention to what customers want. Is there anything else we could do?

Mitigating the Effects of Nonstationarities

In a competitive setting, any project must address cost, performance, marketing features, technical maturity, and time to completion. Yet, *nonstationary environments* imply acquisition projects will continue to experience product configuration changes and other changes that drive up cost and extend schedules. We should deal with changes in a sensible way. Being sensible is tantamount to adopting heuristics[3] to deal with environmental changes. And, what is sensible depends on what we consider to be the most important variables to control. The priority given to cost and schedule will vary product to product, market to market, and threat to threat.

Given the fact that we cannot eliminate the nonstationary aspects of a project's environment, at least three options are available to mitigate the effects of the nonstationarities: (1) control cost, (2) control schedule, and (3) manage changes with discipline. We could give highest priority to cost and try to control cost to avoid the nonstationary effects on cost from the environment. We could just as well constrain schedule to avoid the nonstationary effects on the schedule from the environment. And we must manage the changes in a disciplined way to avoid the worst effects of the nonstationarities.

DESIGN TO COST

The *Innovator's Dilemma* (Christensen, 1997) makes it clear why cost continuously becomes an important factor that affects the competitive position of commercial companies. And newspapers and television newscasters regularly remind us that the cost of defense acquisitions by the U.S. Government repeatedly surfaces as an area of concern to the Congress and taxpayers. When cost is the most important variable, yet a constraint is defined that cost cannot exceed a preset limit, then we are dealing with a *design-to-cost* paradigm.

A design-to-cost strategy aims to control costs by treating cost as an independent design parameter. A substantial fraction (70 to 80 percent) of a product's cost is determined during the product's design/development phase. According to Crow (2000), the elements of a design-to-cost approach include the following:

- Recognition of what the customer can afford
- Definition and allocation of the target costs to a level at which costs can be effectively managed
- Commitment on the part of designers and development personnel
- Stable management to prevent requirements creep
- Understanding of cost drivers and their management in establishing product specifications
- Early use of cost models to project design/development costs in support of decision making
- Active consideration of costs appropriately weighted during development
- Exploration of the product's trade space to find lower cost alternatives
- Access to a database of past costs to provide quantitative information about present cost estimates
- Design for manufacturability and design for assembly to avoid rework and its associated costs
- Identification of functions that have a high cost-to-function ratio as targets for cost reduction

- Consistent cost accounting methods, models, and processes
- Continuous improvement through value engineering to improve products' value over time.

Thus, well-understood techniques and practices are readily available that treat cost as an appropriately weighted design parameter. Adopting these techniques when cost is a high priority can serve to limit costs and thereby reduce the impact of cost growth due to nonstationary environments.

DESIGN TO SCHEDULE

In a military setting, quick reaction implies that a capability is required in the field with high priority in a time period that can be as short as 1 to 3 months. Environments do not change appreciably in that timeframe. Time to market can also be a consideration for commercial firms because of short windows of opportunity. If schedule is the most important variable, and a constraint is defined that project length cannot exceed a relatively short preset span, we are dealing with a *design to schedule* paradigm, which is often also called a *Quick-Reaction Capability* (QRC) paradigm.

We cannot find much written about QRC other than definitions of the abbreviation. But our private industry experience gives us some personal insight into how to accomplish a QRC effort. Basically, a QRC effort relies on the reuse of earlier designs and components, and upon a dedicated, knowledgeable workforce that is committed to completion of the effort in the required timeframe. The reuse of standard parts eliminates the long lead time to design new or nonstandard parts. The reuse of standard manufacturing processes and tools eliminates time to retool or re-plan the manufacture. And techniques that are suggested to implement the *design-to-cost* paradigm suggest further techniques to save time: time correlates with cost. We can reword the recommended elements of the design-to-cost paradigm (cited above) to apply to the QRC paradigm:

- Recognition of when the customer needs the product or capability
- Definition and allocation of schedule milestones to a level at which time can be effectively managed
- Commitment on the part of designers and development personnel
- Stable management to prevent requirements creep
- Understanding of time drivers and their management in establishing product specifications
- Early use of schedule models to project design/development time in support of decision making
- Active consideration of time appropriately weighted during development

- Exploration of the product's trade space to find lower elapsed-time alternatives
- Access to a past experience database to define earned-value milestones realistically
- Design for manufacturability and design for assembly to avoid rework and its associated time
- Identification of components and parts that have a high time-to-capability ratio as targets for schedule reduction
- Consistent earned-value milestone accounting methods and processes to assess technical progress
- Continuous improvement through value engineering to improve the time to market/field.

Thus, inferred techniques and practices are available that treat schedule as a constrained parameter. Adopting these techniques when time is a high priority can serve to limit schedule and thereby reduce the impact of schedule growth due to nonstationary environments.

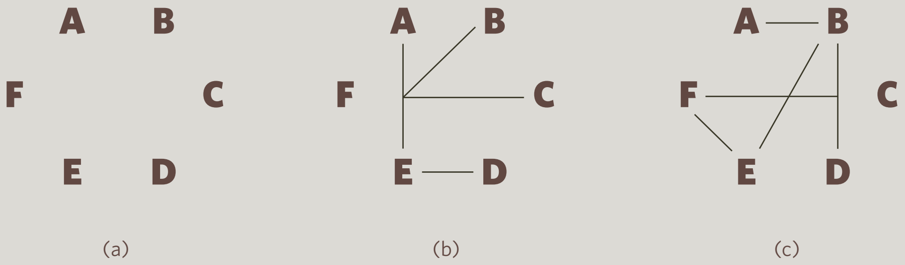
CONFIGURATION AND CHANGE MANAGEMENT

This article is not deliberately focused on a single weapon system or product, which is likely easier to change. Modern acquisitions include systems of systems in an environment of exponentially increasing inter- and intra-dependencies. In an era of net-centric warfare, globalization, and the World Wide Web, interdependencies are unavoidable. In his book *Leading Change*, Kotter (1996, pp. 21, 136–137) discusses the nature of change in highly interdependent systems. Specifically, in highly interdependent environments, a single desired change drives almost everything to change (Figure 4). We think of physical changes to a system as *configuration* changes. But, interdependency becomes a further challenge when various component systems are themselves unstable, for example, because of funding constraints, political climate, or changes in leadership or ownership. Therefore, *change management* deals with nonphysical aspects of a system, such as requirements changes, priority or budget changes, or other changes to established baselines.

Kotter (1996) also highlights an eight-step process of creating major change:

1. Establish a sense of urgency.
2. Create the guiding coalition.
3. Develop a vision and strategy.
4. Communicate the new vision.
5. Empower broad-based action.
6. Generate short-term wins.

FIGURE 4. CONFIGURATION MANAGEMENT USES THE SAME BASIC PROCESS THAT CHANGE MANAGEMENT USES



Note. (a) In a system with independent parts, A can be changed by simply changing A; (b) in a system with some interdependence, several elements (A, E, D) may need to be changed in order to change A; (c) in a system with much interdependence, all elements may need to be changed in order to change A.
(Blanchard & Fabrycky, 2006)

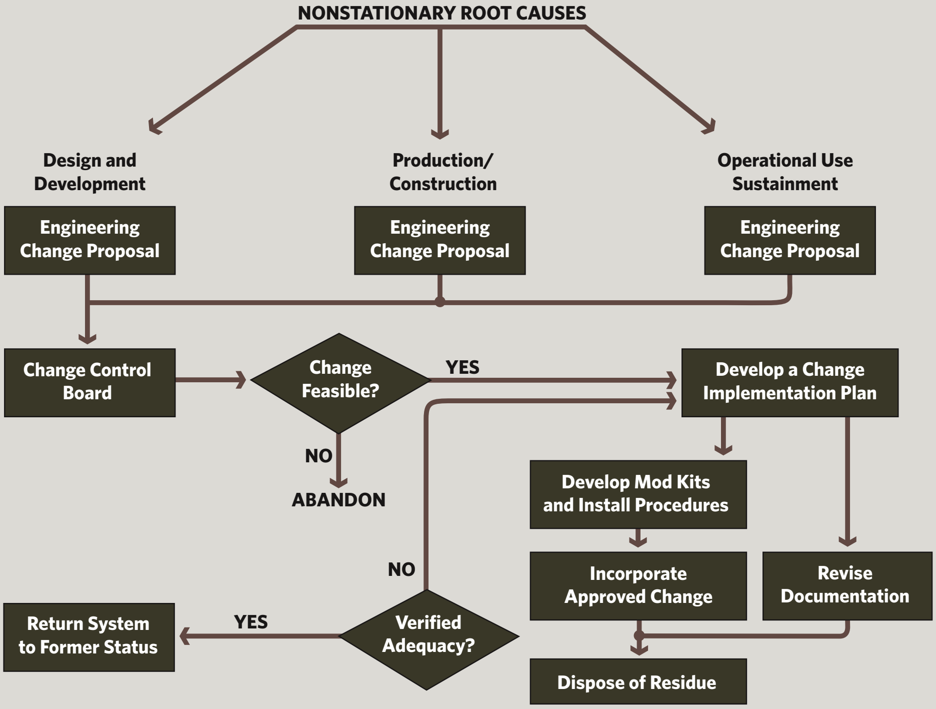
7. Consolidate gains and produce more change.
8. Anchor new approaches in the culture.

While Kotter's eight-step process model is primarily designed for changing organizations, many of the principles contained in this approach are applicable to effective project/program management, especially during periods of frequent change and turmoil. This is especially true if the desired change is more process- than product-based. For example, if a project desires to capitalize on a new technology or address quality problems through manufacturing process alteration, we can see where the Kotter eight-step process is directly applicable.

Configuration management. Change management and configuration management are closely related (Figure 5). The concepts are similar: by controlling or managing proposed changes to a product's or a system's configuration, we are controlling or managing the effect on the product or system of changes in the external environment. Configuration management typically requires a configuration control board chaired by an executive stakeholder; a configuration working group of subject matter experts to analyze proposed changes, and to create and evaluate alternative means to accommodate the change; and a secretariat to record the deliberations and decisions of the configuration control board, and to manage any action items that are assigned.

Change management. Change management is a well-known and respected means to deal with volatile requirements, budget cuts, and other nonstationary root causes of project failures. The definition of change

FIGURE 5. BASIC PROCESS FOR CONFIGURATION MANAGEMENT AND CHANGE MANAGEMENT


NONSTATIONARY ROOT CAUSES
Design and Development
Production/ Construction
Operational Use Sustainment
Engineering Change Proposal
Engineering Change Proposal
Engineering Change Proposal
Change Control Board
Change Feasible?
YES
NO
ABANDON
Develop a Change Implementation Plan
Develop Mod Kits and Install Procedures
Incorporate Approved Change
Revise Documentation
Dispose of Residue
NO
Verified Adequacy?
YES
Return System to Former Status

Note. Adapted from Figure 5.10 (Blanchard & Fabrycky, 2006, p. 138).

management includes at least four basic aspects: (1) the task of managing change, (2) an area of professional practice, (3) a body of knowledge, and (4) a control mechanism. Change can be planned or unexpectedly driven by unforeseen external events; this article addresses the latter. Many believe that the general process of change can be treated separately from the specifics of the situation; thus, acquisition practitioners may seek to leverage the expertise of professional change consultants.

The body of knowledge relating to change management is drawn from psychology, sociology, business administration, economics, industrial engineering, systems engineering, and the study of human and organizational behavior. For many practitioners, these component bodies of knowledge are linked and integrated by a set of concepts and principles known as general systems theory (Skyttner, 2005). Thus, a large, somewhat eclectic body of knowledge underlies the practice of change management upon which many practitioners might agree.

However, the very application of the word *management* in direct association with the word *change* implies that change is an activity or event that lends itself to being controlled (control is a function of management) through the application of logical procedures applicable to standardized, effective, and efficient processes. For this to be true, the volatility of impacting factors must also have some reasonable degree of predictable control. Infrequently, however, is there a case where change is desired while all aspects of the change are predictable. Therefore, although various methods are available by which one can approach change, the challenge of successfully effecting change is directly proportional to the number of nonpredictable aspects.

Summary and Conclusions

Cobb's Paradox, as detailed in this article, is a result of nonstationary causes. Some of these nonstationary causes are not explicitly defined in the acquisition or systems engineering literature before now. Some of these nonstationary causes are not at all easy to manage. So it seems that project failure is not paradoxical as Cobb's Paradox suggests.

Given the fact that project environments can not be expected to remain constant over a typical project's life cycle, we are left with disciplined change management to deal with any changes and heuristic methods to control their impacts. Perhaps if we treat every project as if it was both cost-constrained and schedule-constrained, and we applied disciplined change management techniques, we would avoid many of the project problems analyzed by The Standish Group and so clearly articulated by Martin Cobb.

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ENDNOTES

1. According to The Standish Group, 16 percent of software-intensive projects are successful, while 53 percent are over schedule or budget and 31 percent are cancelled (see http://www.gtislig.org/Documents/ISO%2012207.ppt#265,10,Project Failure Reasons).
2. Note that evolution is driven by feedback from the environment, and is usually interpreted to result in entities that have adapted to the changing environment to become more survivable in it.
3. A heuristic is something that cannot be proven to work all the time, but experience indicates it works well most of the time. A heuristic may also be thought of as a method of solving a problem for which no formula exists so that the solution is based on informal methods or experience and may employ a form of trial-and-error iteration.

EMBRACING UNCERTAINTY IN DoD ACQUISITION

1SG David E. Frick, USA (Ret.)

Uncertainty is an inherent, unavoidable aspect of life that has a significant impact on program or project management, and acquisition in general. The treatment of risk management within the Department of Defense (DoD) as a formal element of acquisition is a topic discussed extensively in the acquisition profession. DoD fares no better than industry in the number of projects or programs that fail to meet cost, schedule, or performance baselines. This article suggests that, overall, the DoD approach to uncertainty is flawed, and that we need substantive changes to the structure and policies of acquisition to become more effective in the discipline of program management.

Keywords: *Acquisition; Risk Management; Opportunity Management; Program and Project Management; Cost, Schedule, and Performance; Continuum of Uncertainty*

image designed by Tia Gray »

Opportunity Management

Background

The "risk management" view that the Department of Defense (DoD) promotes is logical, repeatable, and auditable—but fundamentally flawed. In fairness, the DoD view is shared by virtually every organization and culture. This article will propose a different way to view and address risk management.

No universally accepted definition for risk exists. Tables 1 through 3 represent the range of definitions that can be found within government and industry. Most promote a negative view of risk. The lack of a common taxonomy and the DoD focus of risk as a negative contribute to the practice of ignoring the positive aspects of uncertainty.

The concept of opportunity planning as the complement to risk planning is not unknown, but also is not well supported. Opportunity planning looks at the possibility of good things happening and committing the resources to planning actions to get the most out of those good things. Charette (2003) promotes the view that opportunity should not be merged into a definition of risk. Some have argued against opportunity planning in the conventional sense. Meridith and Mantel (2001) pointed out "…planning is guaranteed to elicit repeated and pointed questions from top management and other stakeholders as they seek to discover why 'nothing is being done.'" In organizations where opportunity planning is an unknown, the pressure to "get on with it" will be great, and opportunity planning—whether a combined or separate process—will likely not receive an appropriate level of attention. I must concede this point. Therefore, I am not advocating opportunity planning as a separate discipline, but rather that we view plans through the lens of uncertainty, which naturally incorporates both risks and opportunities.

Through general use, the term *risk* has become a synonym for the negative aspects of uncertainty. This use is common in contemporary government, industry, and economic theory. When the economics advisors talk about risk-adjusted rates, they are discussing the premium added to rates of return to counter the possibility of economic loss. The government views risk as an assessment of contractor capability to manage cost, schedule, and performance during the performance of the contract. The contractor views risk within the context of market forces (OUSD[AR], 2001, p. 20). For the purposes of this discussion, you will need to keep a different taxonomy in mind.

Consider the real world. Good and bad things happen. In some cases you can affect (amplify or diminish) the impact of happenstance. View this propensity for happenstance as the continuum of uncertainty (Figure 1). On the left, we have bad things; on the right—good. As we get farther from the center, the degree of goodness and badness increases. Now define everything on the left as "threats" (*t*) and everything on the right as "*opportunities*" (*o*). Risk is the element of uncertainty that is a function of the probability of bad things happening and the severity of their impact

TABLE 1. NEGATIVE DEFINITIONS OF RISK

Standards Document	Definition
Norges Standardiseringforbund NS5814:1991	"...the *danger* that undesirable events represent."
IEC 3-3-9:1995 and British Standard BS8444-3:1996	"...of occurrence and the consequence of a specified *hazardous* event."
UK Construction Industry Research and Information Association: 1996	"...chance of an *adverse* event..."
Canadian Standards Association CAN/CSA-Q85-97:1997	"...the chance of *injury* or loss."
UK CCTA MSP 1999	"Events or situations that may *adversely affect* the direction of the programme, the delivery of its outputs or achievement of its benefits."
US DOD DSMC 2000	"...potential *inability to achieve* overall program objectives."
IEEE 1540:2001	"...the likelihood of an event, hazard, threat, or situation occurring and its *undesirable consequences; a potential hazard.*"

Source: David Hillson, Effective Opportunity Management for Projects: Exploiting Positive Risk, 2004, p. 28

TABLE 2. NEUTRAL DEFINITIONS OF RISK

Standards Document	Definition
UK Association for Project Management Guide 1997	"...an uncertain event or set of circumstances which, should it occur, will have *an effect* on achievements of ...objectives."
Standards Australia/New Zealand AS/NZS 436:1999	"...the chance of something happening that will have *an impact* upon objectives."
British Standard PD 6668:20	"...chance of something happening that will have *an impact* upon objectives."
British Standard BS IEC 62198:2001	"...combination of the probability of an event occurring and its *consequences* for project objectives."

Source: David Hillson, Effective Opportunity Management for Projects: Exploiting Positive Risk, 2004, p. 28

TABLE 3. BROAD DEFINITIONS OF RISK

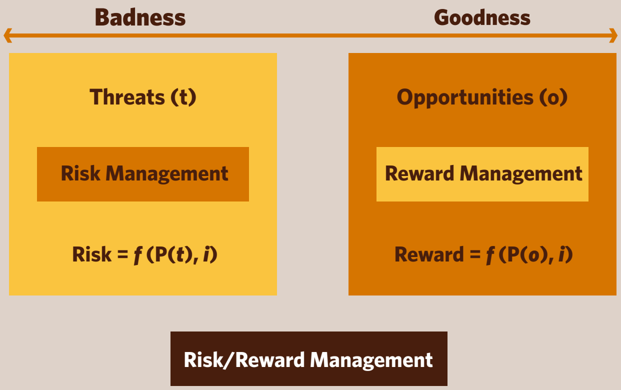
Standards Document	Definition
British Standard BS ISO 1006:1997	"Potential *negative* events and … *opportunities for improvement* …the term risk covers both."
UK Institute of Engineers Guide 1997	"…a threat (*or opportunity*) which could affect adversely (or favorably) achievement of the objectives."
British Standard BS6079-1:2002 and BS6079-2000	"…combination of the probability …of a defined *threat or opportunity* and the magnitude of the consequences."
Project Management Institute PMBOK 2000	"…an uncertain event or condition that, if it occurs, has a *positive or negative effect* on a project objective …includes both *threats* to the project's objectives and *opportunities* to improve on those objectives."
British Standard BSI PD ISO/IEC Guide 73:2002	"…combination of the probability of an event and its consequences …consequences can range from *positive to negative*."
UK Office of Government Commerce MOR 2000	"Uncertainty of outcome, whether *positive opportunity or negative threat.*"
UK MOD Risk Management Guidance 2002	"…a significant uncertain occurrence …defined by the combination of the probability of an event occurring and its consequences on objectives …the term "risk" is generally used to embrace the possibility of both *negative and/or positive consequences*."

Source: David Hillson, Effective Opportunity Management for Projects: Exploiting Positive Risk, 2004, p. 28

(*i*). High probability and high consequences result in high risk, while low probability and low consequences result in low risk. On the right side of the continuum we have the complement to risk—reward. This method of quantifying risk is not substantially different from those offered by Hillson (2004), Heerkens (2002), Cooper (2005), Kerzner (2001), and others.

The continuum of uncertainty, as described here, differs little from the *Risk Management Guide for DoD Acquisition*, except that the guide presents probability and consequence as two discrete variables in a two-dimensional

FIGURE 1. THE CONTINUUM OF UNCERTAINTY



matrix. In contrast, please view both risk and reward as the product of a continuous (undefined) function—not simply multiplicative, but sensitive to the risk aversion of the organization and the political environment.

The guide defines risk as "a measure of uncertainties [*sic*] in achieving program performance goals and objectives within defined cost, schedule, and performance constraints." However, it in no way implies the potential positive aspects of these uncertainties. The terms used, e.g., "schedule slip, budget increase, cannot meet key program milestones" concentrate only on the negative aspects of uncertainty. This is not surprising. The guide specifically states, "While such variation could include positive as well as negative effects, this guide will only address negative future effects…" (DoD, 2006, p. 1). Most of us tend to think of risk solely in terms of negative consequences. Few academicians or organizations even address the positive potential of uncertainty. The Project Management Institute (PMI), in the 4th edition of the *Guide to the Project Management Body of Knowledge*, now acknowledges the potential of positive events, but the concept is not fully matured in the project management profession (PMI, 2008).

MOST OF US TEND TO THINK OF RISK SOLELY IN TERMS OF NEGATIVE CONSEQUENCES.

Although the PMI definitions of the terms "project management" and "program management" are clear and distinct (PMI, 2008), DoD's definitions are quite ambiguous (DAU, 2005). For the purposes of this discussion, consider project and program management as synonymous terms. In practice, DoD program and project managers (PMs) almost exclusively concentrate on the negative aspects of uncertainty for four specific reasons.

1. Risk aversion is an entrenched culture throughout DoD.
2. PMs have little flexibility.
3. Culturally acceptable practices to address uncertainty are inadequate.
4. DoD PMs concentrate on tangible, actionable events (events that can be mitigated) and spend much less time on the abstract.

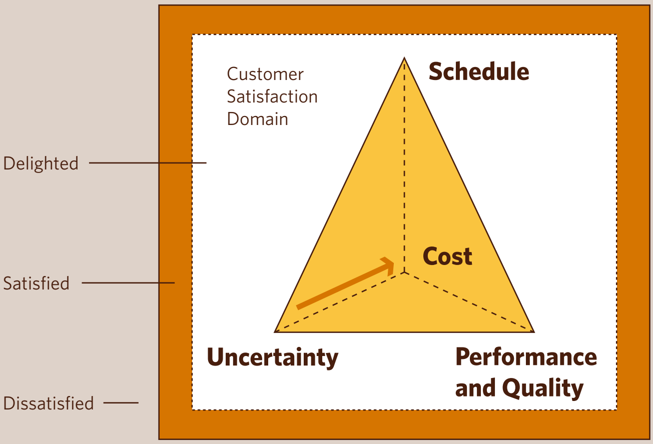
RISK AVERSION

DoD is risk averse. Strategists and decision makers will routinely forego potential rewards to reduce **even the perception of failure**. While they parrot the cliché "big risk–big reward," their actions eschew risk. This, I believe, is a consequence of a zero defects culture that is incapable of embracing "honest failure" as a medium for creating knowledge. I am reminded of the words of a distant regimental commander of mine, "People tell me our junior officers don't have the freedom to fail. I say they are right. I don't want them to fail. I want them to succeed." His heart may have been in the right place, but his method was flawed.

LITTLE FLEXIBILITY

Most PMs have little trade-off flexibility. PMI and others view the success of a project or program on how well it adheres to three elements—cost, schedule, and performance. I posit that uncertainty should be considered

FIGURE 2. SATISFIED CUSTOMER



as the fourth leg of the otherwise three-legged stool. From the customer's perspective, there exists a boundary that cannot be crossed by any of these four parameters if customer satisfaction is to be maintained (Figure 2).

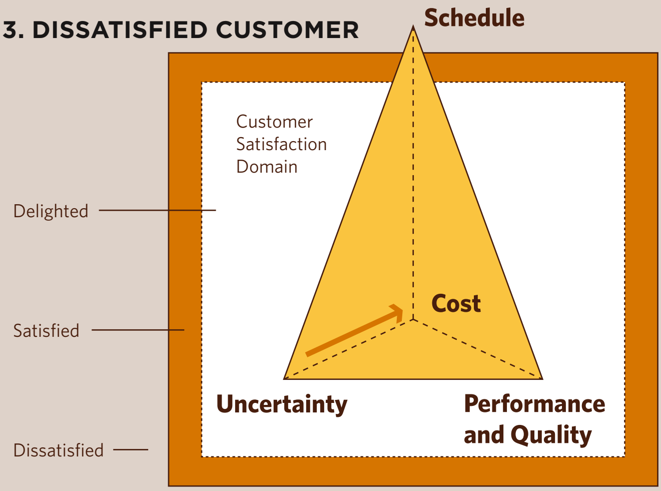
Although cost, schedule, and performance are generally defined, uncertainty is not. This boundary is hard to define and changes from customer to customer and over time. Often, a PM does not know the location of the uncertainty boundary until after it is breached. A poorly defined project or the dreaded scope creep further blurs the boundary. The PM is able to maneuver within the satisfaction boundaries, trading cost for performance for schedule, and sometimes for uncertainty, as long as the overall boundary is not pierced (Figure 3). In DoD, unfortunately, cost is the most rigid constraint. In the risk-averse culture in which DoD PMs operate, risk absolutely cannot increase and, therefore, is *not a candidate for the trading block*. This leaves schedule and performance as the only negotiable constraints. In practice, schedule slips are seldom palatable, and performance becomes the bill payer.

PMs routinely view it as sound program management, within the limits of the available budget, to spend money or reduce performance to reduce uncertainty, but the converse is uncommon, i.e., rarely is a PM allowed to increase uncertainty to save money or improve performance. If a PM was to reduce spending thereby increasing uncertainty and things went wrong, the fallout would likely be career-ending. I have colleagues who suggest this is an overstatement; maybe, but the "all-in" gamble does not happen.

ACCEPTABLE PRACTICES ARE INADEQUATE

DoD's view of handling risk, as outlined in the guide, presents four general approaches:

FIGURE 3. DISSATISFIED CUSTOMER



1. **Risk control.** Controlling risk encompasses efforts to mitigate (reduce) the probability or impact of a *previously identified event.*
2. **Risk avoidance.** Avoiding risk includes changes in cost, schedule, performance, or design specifications that eliminate the root causes of a *previously identified event*.
3. **Risk assumption.** Assuming risk means accepting the risk of a *previously identified event* without specification. DoD includes establishing cost or schedule reserves within the category of assumption, although the practice of establishing formal reserves is uncommon.
4. **Risk transfer.** DoD's definition of risk transfer differs from most others. In industry, transfer means "to insure." However, since the government self-insures, DoD transfer means reallocating risk among elements of the program or between the government and the contractor. The assertion is that this transfer will diminish overall risk or allow management to concentrate on specific areas of the program. Of course, when the responsibility to accept the consequences of uncertainty is assumed by a company, it tends to increase its price as compensation (DoD, 2006).

THERE WILL ALWAYS BE AN UNDEFINED AND UNKNOWABLE SPECTRUM OF UNPLEASANT THINGS THAT CAN HAPPEN.

Both control and avoidance assume that most of the pitfalls that lead to potentially increased risks have been identified. Plans are developed to identify trigger events and react to these events (control), or actions are taken to reduce the number of items (avoidance) on the list. In contrast, no list of risk events or risk triggers is going to be comprehensive. There will always be an undefined and unknowable spectrum of unpleasant things that can happen. Neither of these approaches (control, avoidance) addresses this fact.

Assumption covers this domain of the unknowable—although the DoD guide does not acknowledge this purpose. In practice, assumption of both the known and unknown is most often a disingenuous pronouncement. While the concept of a management reserve is a well established practice in industry, I have yet to meet a single government PM whose reserve survived the gauntlet of program reviews, sweep ups, agency taxes, or end-of-year "unfunded requirements." In reality, management reserves seldom exist formally, and if they do, seldom survive, particularly when fiscal boundaries are relevant. Unfortunate events result in schedule slips, cost overruns, or performance reductions. In practice, baselines are adjusted to comport with reality, or the number of "required" units shrinks to meet current resources.

CONCENTRATE ON THE TANGIBLE

Lastly, DoD PMs tend to concentrate on foreseeable events to the exclusion of all others. Wysocki and McGary (2003) note, "…if you are certain that an event will occur; it's certainty. This type of event [should not be] handled by risk management because it will occur. No probability is involved." PMs commonly address relatively certain events in risk management plans. Certain (or high-probability) events better justify resources and require less abstract thought to address; however, these events should not be addressed in plans. They should be considered constraints. Plans are the place for contemplating the unknown and the uncertain.

With the 6th edition of the guide, DoD introduced the term "issues." Risks are potential events in the future, but issues are events that have occurred and must be resolved. I suggest a slightly different set of definitions. Possible future events that are not known or are unknowable are "unknowns." Possible, but identifiable future events are "constraints." Events that have occurred are "issues." The difference is subtle, but important. Issues must be actively managed (resources applied). Resources may be applied to constraints but they need not be, depending on the uncertainty tolerance of the program. Unknowns should be contemplated, "what if" strategies should be formed, but resources should not be applied unless they are unconstrained.

Note that I avoided using the term risk in the unknowns-constraints-issues paradigm. "Risk" should have the narrowest of definitions—a function of probability and impact. The units of risk are dollars. As in the financial world, DoD should only speak in terms of "risk-adjusted budgets" or "risk-adjusted schedules," not "risks that need to be mitigated."

A Different View

The distribution of events, like so many other things in nature, is similar to a normal curve (Figure 4)—really good and really bad things occur infrequently, but inconsequential events are relatively frequent. At the extreme ends, the *Black Swans* are found (Taleb, 2007). Figure 5 is a visualization of this point. PMs tend to concentrate their attention in the area just to the left of the mean. The area to the right is relatively ignored. The area to the extreme left is comprised of very low-probability events and events that are unknown or unknowable. Although program managers lose sleep over this area, decisive planning is very hard and usually considered to have too little potential for a positive return on investment.

FIGURE 4. NORMAL DISTRIBUTION OF NORMALITY

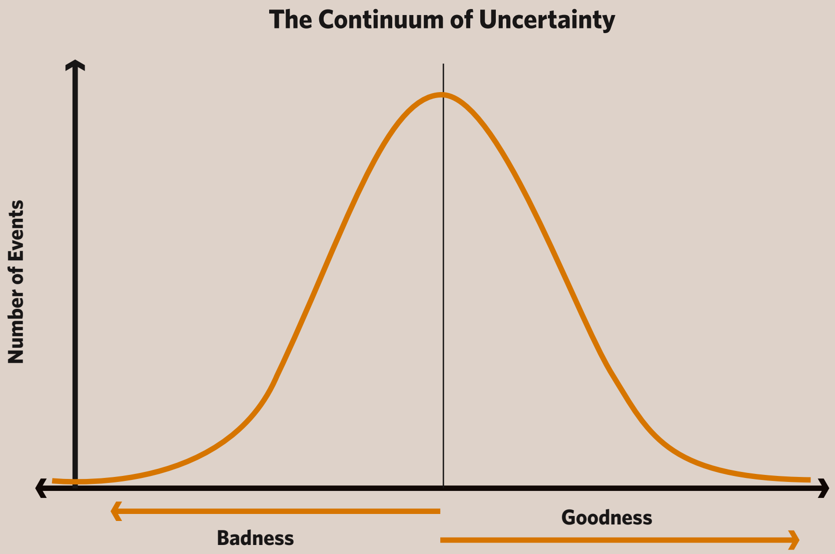
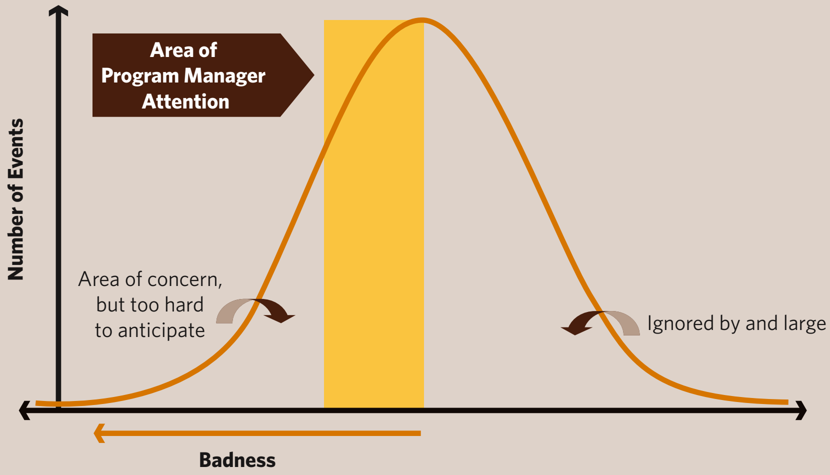
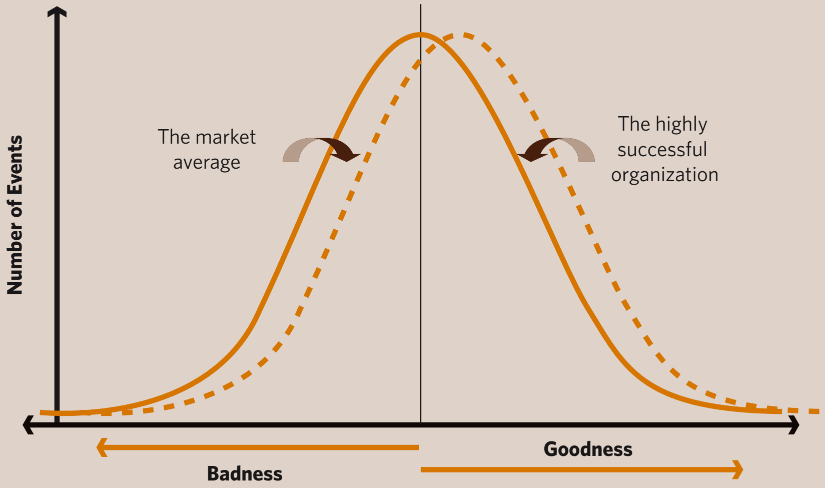

The Continuum of Uncertainty
Number of Events
Badness
Goodness

FIGURE 5. AREA OF PM ATTENTION


Area of Program Manager Attention
Number of Events
Area of concern, but too hard to anticipate
Ignored by and large
Badness

Just for comparison, businesses—especially risk-averse businesses—tend to make structural changes in their processes that increase the kurtosis of the curve (Figure 6). By decreasing the volatility of business—decreasing the incidence of the extremes happening—businesses develop a reputation of stability. The market likes stability and predictability. Ideally, business wants to make other changes that shift their specific curve towards the good side. In practice, highly successful businesses are only 1–2 percent more profitable than their competition, so the shift in the curve is not that significant. Trial and error can be a successful approach. The danger is the

FIGURE 6. A VIEW OF BUSINESS



dearth of timely feedback. Most often, management cannot tell that its change in strategic direction has put the business on a course for disaster until it is much too late to adjust.

How does a successful business shift its curve towards goodness?

1. **It cultivates a culture that encourages risk taking and innovative thinking, but does not punish honest failure.** This will increase the number of events occurring at both extremes. The management task is to evaluate opportunities and create an environment where the good outcomes outnumber the bad. Some companies even hold “failure parties” as a medium to publicly reward honest failure. Failures that happen early and inexpensively, and contribute new insights should be more than just tolerated, but celebrated.

   Getting good at failure doesn't mean encouraging anarchy in your organization. It means creating an environment safe for risk taking and sharing war stories—bringing in outsiders to provide analyses and advice, and absorb the new knowledge. It means carving out time to reflect on failure, not just success.
2. **It facilitates the reasoned inculcation of unanticipated discovery into business processes.** Some might define this as “agility.” Be cautious. Many businesses believe agility means jumping on the bandwagon and adopting every new technology, management practice, or manufacturing process that comes down the pike just to maintain the competitive advantage. If competitors are doing it, then we must. This belief leads to excessive changeover costs, since many new “cutting-edge technologies” or “management practices of the

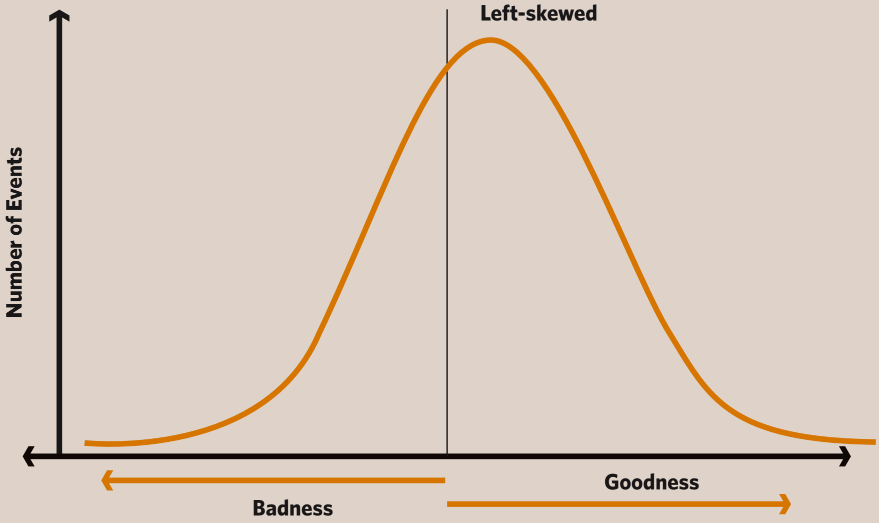
day" seldom pass the test of time. Adopt the latest operating system only after service pack one has been released.

3. **Successful managers "trust their gut" in selecting business projects.** A selection process that relies solely upon a dispassionate business analysis is dangerous. Depending upon the study used, 70–80 percent of all projects fail to achieve anticipated cost, schedule, and performance milestones. Decision theory would suggest that the principal causes are cognitive and personal biases, rational ignorance, and plain hubris. No project champion would green light a project that anticipates a loss. Human nature urges project sponsors to be optimistic in making cost and revenue predictions. The decision authority must temper the wild enthusiasm of the project champion with the tacit knowledge acquired through experience. At the subconscious level, people are able to recall experiences and previously synthesized knowledge (wisdom), and apply it to the explicit knowledge (business case) at hand. Malcolm Gladwell (2005) refers to this as the power of *Blink*. Successful leaders embrace what they know, even if they cannot explain it in words. They do not rely solely on the business case analysis.

DoD can also create a structure that left-skews the curve (moves the mean towards goodness—Figure 7). To move the curve, the structure of and the laws guiding the federal acquisition system must be significantly changed. As former Speaker of the House Newt Gingrich is wont to say, "Real change requires real change." The federal acquisition laws and structure have evolved over the last two centuries to meet the changing needs of society. They have served their purposes, but the pace of change in contemporary society is so fast that the evolved structure is unable to react quickly enough to meet emerging requirements. I am not talking just about the pace of technology, but also the dynamic nature of the market; the changing face of our enemy; and the speed with which our smaller, more agile, greater risk-taking adversaries are able to adapt to our tactics, techniques, and procedures, rendering our plans, defenses, and infrastructure impotent. I believe that the underpinning structure contributes to our tendency to prepare to fight the last war, e.g., the "Battleship" Admirals of the 1930s and our inability at the turn of the 21st century to initially defeat and protect the nation's armed forces from improvised explosive devices.

We collectively have lamented the glacial speed of the extant acquisition system, decrying why it takes 15–20 years to design, build, and deliver a new naval vessel; why our major weapons, telecommunications, and satellite systems are antiques on the day they are delivered; and why it takes years to successfully effect a major acquisition under conditions of

FIGURE 7. NEGATIVE SKEWING OR LEFT-SKEWED



full and open competition. Unfortunately, we have done little to effectively address our lamentations. Yes, we have made some minor improvements at the edges—simplified acquisition authority does ease the bureaucracy to a small degree—but not enough. Major systems still take too long to deploy. A significant contributor to this lethargy is our approach to full and open competition. I am not advocating the elimination of competition—far from it. Competition is good. Greed is good (from the stockholders' perspective). Competition keeps greed in check. We need full and open competition in a *full and open free market.*

So what can we do to shift the curve towards goodness?

1. **Stop the madness of technology-driven acquisition.** Engineers "love" technology! Historically, DoD has subscribed to the theory that the United States "must" be able to technologically defeat the potential capability of every potential adversary. The consequence of this belief is an over reliance on "bleeding-edge technology." Major programs are often based on the promise of unproven or emerging technology, e.g., the propulsion system for the DDG-1000. The sad truth is that sometimes emerging technologies never actually emerge on time to meet program schedules. Cost overruns, schedule slips, and reduced capability are the natural consequence of this gamble. Supposedly, we are addressing this issue by requiring that all prototypes be "mature" by Milestone B. I am not convinced that sliding the uncertainty in technology development to the left in the

acquisition cycle makes any difference in the long run. Who bears the cost of failure in the short run may shift slightly from the government to industry, but in the long run the citizenry will still bear all the ultimate costs. Technology must be mature prior to Milestone C. Whether it should be mature before or after Milestone B is debatable. One factor that may tip the scale is whether business proves to be better disposed than government in recognizing and admitting failure.

In the 1967 6-Day War, Israeli tank crews were arguably more effective against their contemporary enemy crews despite a numerical and technological disadvantage. The argument that our troops only deserve the best is specious. No value is to be found in developing a technological advantage when you cannot sustain the force. We will never be able to afford all of the technology that we want. I understand the desire to rely on technology to reduce the manpower requirements of the DDG-1000—manpower costs are by far the most expensive component of any system's life-cycle costs—but I cringe at the thought of a call for "all hands man your fire stations." With a crew of only 140 and little redundancy, the fire crews may be woefully small.

2. **Truly accept and plan for the unknown.** Business insures against the unforeseen with insurance or management reserves. The government gives the practice passive acceptance, but in reality, management reserves for the government program manager very rarely exist—unless they are hidden somewhere, which speaks to integrity and openness. The only way to adjust for bad events while maintaining planned schedule and performance is to add money. Conversely, programs should not be punished by losing resources as a consequence of budget underruns. These underruns are often ephemeral and will be erased by future overruns. Indiscriminate budget reductions when good things happen are a formula for program failure. Congress must express its collective will to address the unforeseen by authorizing formal program reserves. Congress can tightly control these reserves, but they must be authorized.

   Program budgets must be couched in terms of uncertainty. Decision makers and Congress should have the full story—the most likely costs and the risk-adjusted costs. Congress should know that the new, high-tech $1 widget will cost us $3 each if everything goes wrong. DoD is not intentionally misrepresenting the most likely costs of programs; but today, uncertainty is addressed in subjective terms. We tend to be optimistic or success-oriented. "Moderate risk" may mean different things to different people, but dollars are objective. We might debate whether moderate risk means $2 or $20, but once we come to agreement, the decision becomes an objective one. If Congress does not believe that a program warrants committing to a reserve, the program can be quashed before it starts. Killing a program early eliminates the unpleasant consequences of cost overruns and a public perception of incompetence.

3. **Truly embrace agile acquisition.** If the circumstances can tolerate multiple rounds of full and open competition, then such an approach should be the norm. However, for commercial items, executives should be allowed to form and operate under strategic alliances—something the commercial world uses to great success. When we buy toilet paper, why do we saddle ourselves with the same rule set used to buy tanks? This greater authority to act on behalf of the people must be coupled with more severe consequences for acting unethically or illegally—which takes us to the next topic.
4. **Leaders must tolerate honest failure.** Sometimes people of pure heart and honest intentions fail. This is especially true in conditions of uncertainty and when we are striving to achieve stretch goals. Honest failure must not only be tolerated but rewarded. Humans learn by analogy. We must see both success and failure in order to learn. If Edison had stopped after 100 or 500 failed experiments, he would not have invented the light bulb. We can and should punish dishonest failure—waste, fraud, abuse, negligence, or dishonesty, and do so with fanfare. We should also reward honest failure with equal fanfare.
5. **Grant programs multiyear budgeting authority as the rule and not the exception.** The annual appropriations process is too costly, too ineffective, and a constant annoyance to resource managers and the defense acquisition workforce as they fight to meet end-of-fiscal-year deadlines. Program managers have been known to adjust resource decisions to comport with annual appropriations even when these decisions were less than optimal. I understand Congress's desire to not commit future Congresses; but like the family, agencies and program managers should be allowed to adjust for smart purchases. I also understand the allure of annual appropriations, but a biennial appropriations cycle would be much more efficient, and Congress should give up a little control to *increase* efficiency. Whether you meet a milestone in this fiscal year or next should never be a life-or-death decision for a program.

6. **Business and government view risk differently.** When the government speaks of risk, it most often refers to technical, schedule, or cost risk. The government must understand that a company interprets risk in a different way. To a company, risk is the potential impact on the value of events not proceeding as planned. Risk to a company is, therefore, a measure of the likelihood of achieving the financial objectives of the project (OUSD[AR], 2001, p. 17).

To meld these disparate views into a unified outlook, we must establish and retain a truly qualified cadre of PMs for major programs. PMs must be qualified "before" they are assigned to critical acquisition positions. As a matter of policy, we do this. However, what DoD considers as qualified looks much different from what the rest of the world considers qualified. Service PMs tend to be field grade officers who have not made project management their profession of choice. The skill set to be a successful "steely eyed killer" is vastly different from the skill set of the successful PM.

Turn major program acquisition over to a permanent cadre of civilian professionals trained in the profession of program management as defined both by DoD and the rest of the world. The DoD PM should be certified as a Project Management Professional (PMP) to appreciate the business view of projects; hold a graduate degree in project management (or an MBA) to better understand the financial aspects of business; and, to add the DoD criteria to the mix, meet the Defense Acquisition Workforce Improvement Act standards appropriate for the PM's scope of responsibility. With a median salary in industry of around $120,000 for qualified PMs, DoD will frankly face a challenge in retaining a qualified workforce; however, we have the authorities in place to meet that challenge.

This may seem a slap in the face of the Federal Acquisition Institute (FAI) and the Defense Acquisition University (DAU). That is not the intent. Both FAI and DAU serve the public well in educating PMs in the mysterious ways of the federal acquisition process. Taxpayers also receive value from the knowledge and skills acquired by PMs at FAI and DAU in that these institutions afford PMs an excellent opportunity to network in the nongovernment realm and understand the perspective of their counterparts in industry.

Cadres of professional civilians who truly embrace project and program management as a profession will, at a minimum, establish a framework in which DoD can better retain the knowledge of its acquisition professionals. A former commander of mine, now an agency head, was overheard recently saying, "They shouldn't be called 'lessons learned'; they should be called 'lessons observed.'" How many times must we observe the same lesson before it is learned and becomes institutional knowledge?

Conclusions

What I have presented here is clearly opinion, but I hope it is sufficiently provocative to spur further debate. No one can reasonably deny that the world has changed significantly from the time the policies of DoD acquisition were first penned. Today's world is much more dynamic. Seemingly innocuous events across the globe are much more likely to affect our plans and programs—for the good or bad. We need to actively view and embrace the continuum of uncertainty and not simply concentrate on the negative. We constantly ask ourselves, "What bad things have happened that *force* me to change my plan?" What is so unnatural in asking at the same time, "What good things have happened that *allow* me to change my plan?" In the long run, is spending admittedly limited resources in the hope of good things happening prudent and beneficial to the taxpayer? I encourage those of you of like mind (and even those of a differing opinion) to put pen to paper and bring forth your arguments.

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EMBRACING UNCERTAINTY

ADAPTATION OF PORTER'S FIVE FORCES MODEL TO RISK MANAGEMENT

John F. Rice

Prominent tools for assessing and managing risk include risk cubes, risk burndown charts, and automated risk management software. They are generally lacking, however, in accommodating ideation and brainstorming to identify potential problems. A suggested approach for improving the process is to apply *strategic management models* currently used as commercial best practices. Many are directly applicable and adaptable to *systems engineering* processes including *risk management*. This article presents traditional risk tools and introduces a complementary management model tailored to the identification, scoring, and tracking of potential program threats. Additional management models are presented for further investigation and adaptation.

Keywords: *Risk Management, Five Forces Model, Systems Engineering, Strategic Management Models, Armed Reconnaissance Helicopter (ARH)*

image designed by Lapedra Tolson »

Brainstorming
potential problems

In this article, the author presents typical SE models such as the work breakdown structure, functional flow block diagram, and risk cubes, and explains how they are analogous to organizational hierarchies, enterprise flowcharts, and uncertainty matrices, respectively. Particular emphasis is placed on risk management and the associated adaptation of a strategic management model.

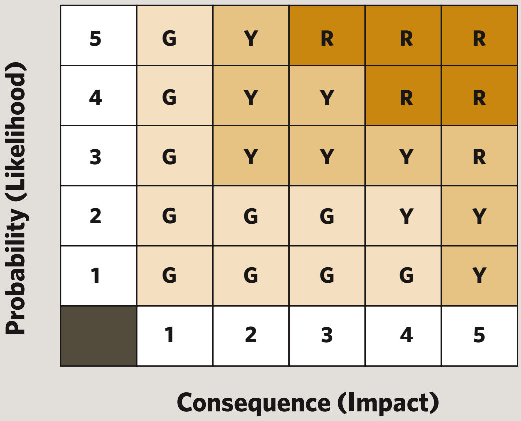
The linkage between strategic organizational management and systems engineering has been observed for decades. Management theorists have compared corporate organizations to "systems" (Bertalanffy, 1956, pp. 1–10). Optner (1968) described organizational systems as follows: "A system is here defined as a set of objects together with relationships between the objects and between their attributes related to each other and to their environment so as to form a whole."

Jenkins' (1974) definition of a system is a complex grouping of human beings and machines for which there is an overall objective. Expressed in terms of systems engineering (SE), Hall (1962) viewed this domain as "operating in the space between research and business, assuming the attitudes of both."

Traditional Risk Management

Traditional Risk Management (RM) models have included risk cubes (Figure 1), risk burndown charts (Figure 2), and RM software applications such as Active Risk Manager, Risk Matrix, and Risk+ (DoD, 2009). This article addresses the adaptation of a strategic management tool to model risk as part of a structured SE process (DoD, 2006). By tailoring the management tool for RM, the systems engineer has another "arrow in the quiver" to perform the risk function or to complement existing methods.

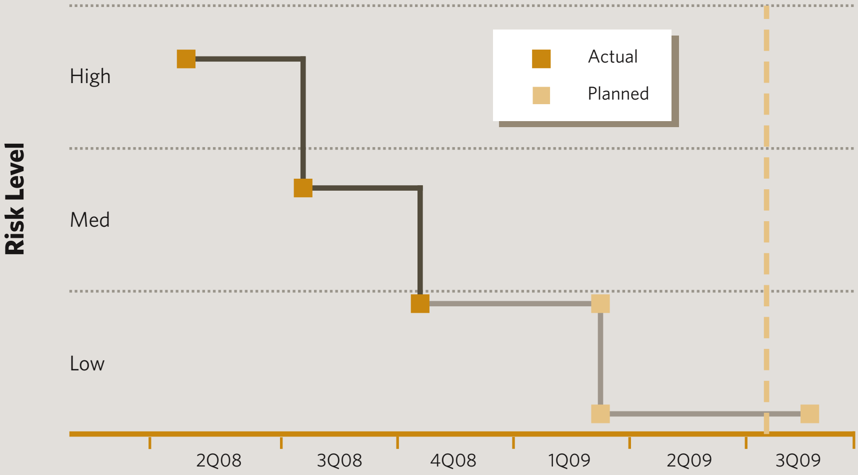
FIGURE 1. RISK CUBE



5	G	Y	R	R	R
4	G	Y	Y	R	R
3	G	Y	Y	Y	R
2	G	G	G	Y	Y
1	G	G	G	G	Y
	1	2	3	4	5

Probability (Likelihood)
Consequence (Impact)

FIGURE 2. RISK BURNDOWN CHART

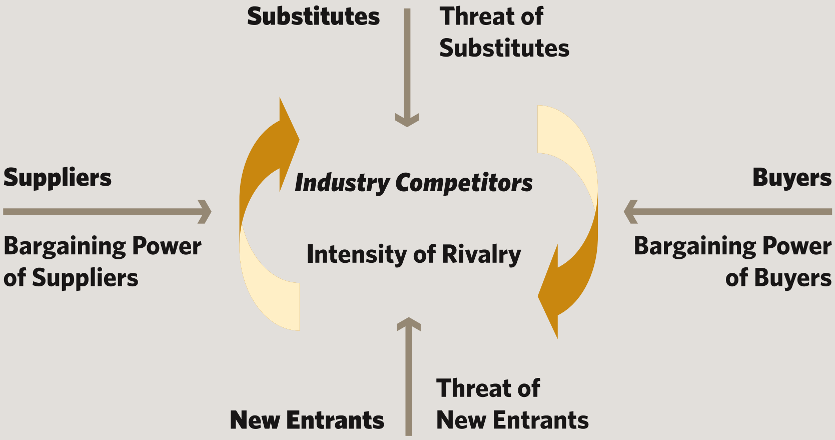


Five Forces Model

The strategic management model and focal point of this article is known as the *Five Forces Model* (Barney, 1996, p. 6). Its originator, Dr. Michael Porter, University Professor at Harvard Business School, developed the tool for competitive advantage analysis within specific industries. (Other management tools adaptable to RM/SE functions are described in subsequent discussion on "Additional Models.")

As shown in Figure 3, the center block depicts intensity of rivalry among industry competitors. The external forces—new entrants, bargaining power of buyers and suppliers, and substitutes—are shown as the threats acting on the industry.

FIGURE 3. PORTER'S FIVE FORCES MODEL


Substitutes
Threat of Substitutes
Suppliers
Bargaining Power of Suppliers
Industry Competitors
Intensity of Rivalry
Buyers
Bargaining Power of Buyers
New Entrants
Threat of New Entrants

The purpose of developing a model of environmental threats is to aid managers in evaluating these threats so they can become more successful in creating strategies to neutralize them. Porter and Millar (1985) contend the five characteristics of corporate structure can threaten the ability of an organization to either preserve or produce above-normal returns.

Adaptation to Risk Management

Adapting the Five Forces Model to RM involves replacing intra-industry rivalries and competitive threats with the following risk forces (a.k.a. *the five I's*):

- Internal organization
- Industry
- Information
- Infrastructure
- Influences

For discussion purposes, these forces are stated in the current tense. Actual risks would be stated in the future tense with root causes, and probabilities and consequences.

Internal organization risks include enterprise functions such as task sharing, personnel loads, cross training, assignment duration, and related parameters. Industry risks are associated with contractor and subcontractor organizations, technology maturity, product support, and contractual matters.

Information risks include software availability and functionality, information system backup, and network security. Infrastructure refers to physical security, communications networks, event recovery, and safety. Influences include external demands (e.g., meetings, travel), senior leadership support, and policy mandates.

It should be noted that the tailoring of Porter's model to a program-level effort involves more than a change in nomenclature. It requires a change of perspective from an industry view to an enterprise view. Additionally, the forces are no longer competitive in nature, but risk-related.

The RM version of the Five Forces Model, hereafter called *RM5*, has numerous benefits, including the ability to:

- Perform back-of-the-envelope cursory analyses
- Promote and capture brainstorming among groups
- Document the identification of potential risks from the brainstorming session
- Categorize the risks into one of the five I's

- Measure the impact of each risk using a consensus scoring approach
- Track risk trends through comparison of RM5 iterations.

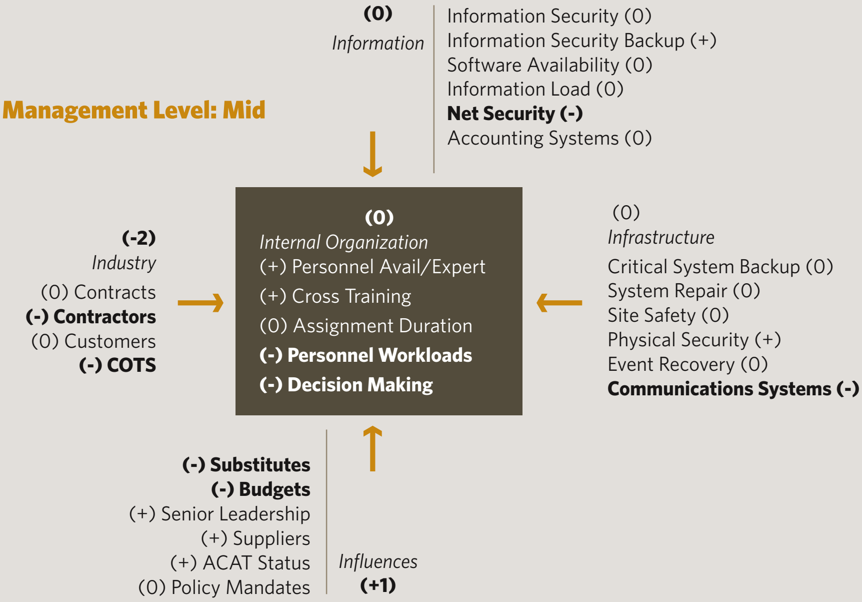
As a consequence, it can be shown all categories have some degree of risk, and those items could be targeted for mitigation. The risks for either approach could be weighted to underscore their importance.

Practical Application

The author initially utilized RM5 in 2004 to assess risk in the U.S. Army's *Armed Reconnaissance Helicopter (ARH)* Product Office—specifically, while serving on the proposal evaluation team. As shown in Figure 4, each of the five I's was examined for candidate risks such as contractor (Industry), communications (Information), budget (Influences), personnel (Internal), and system risks (Infrastructure).

The identification of risks was generated from subject matter experts, experienced systems engineers, and brainstorming sessions. Initially, some of the submitted risks were of low significance or relevance. Through iterative reviews, the candidates were promoted or demoted to validate their importance.

FIGURE 4. RM5 MODEL


(0)
Information
Information Security (0)
Information Security Backup (+)
Software Availability (0)
Information Load (0)
Net Security (-)
Accounting Systems (0)
Management Level: Mid
(0)
Internal Organization
(+) Personnel Avail/Expert
(+) Cross Training
(0) Assignment Duration
(-) Personnel Workloads
(-) Decision Making
(-2)
Industry
(0) Contracts
(-) Contractors
(0) Customers
(-) COTS
(0)
Infrastructure
Critical System Backup (0)
System Repair (0)
Site Safety (0)
Physical Security (+)
Event Recovery (0)
Communications Systems (-)
(-) Substitutes
(-) Budgets
(+) Senior Leadership
(+) Suppliers
(+) ACAT Status
(0) Policy Mandates
Influences
(+1)

Note. COTS = Commercial Off-the-Shelf; ACAT = Acquisition Category

Scoring and weighting of risks are also features of RM5. Scoring is performed in a manner similar to Porter's model where +, 0, and – are used to indicate a positive, neutral, or negative condition. In risk terminology, this is stated as a positive trend, unlikely/unknown risk, or negative trend.

Weighting can be applied by assigning multiple notations (e.g., + +) based on consensus or expertise, or through numerical methods such as regression analysis. Using historical run data, a trend analysis can be performed and plotted as curves, Gantt charts, or similar illustrations.

Results from ARH

When initially applied to ARH as a brainstorming effort, several risks were identified beyond the cost and schedule constraints formally tracked by the Product Office. Certainly a Product Office's risk management resources are limited, and not all risks can or should be tracked. However, the time and effort to apply RM5 and identify other significant risks proved valuable.

The results of this initial run yielded the following example risks not tracked by the Product Office:

- Market research was indicating **COTS/MOTS** (commercial off-the-shelf/modified COTS) technical maturity might be lower than originally assessed. This raised the likelihood of future, unplanned subsystem development with the consequence of depleted resources.
- **Substitute** technologies and platforms were lacking. The likelihood of a gap in fielded capabilities was evident, with the consequence of compromised operational missions.
- **Enterprise Communications Systems** for the proposal evaluation team were limited compared to typical office systems with e-mail and instant messaging. This raised the likelihood that critical information during proposal assessment could remain isolated, with the consequence of unreported risks or opportunities.

During subsequent runs, these risks remained notable, and additional RM5 risks proved to be consequential:

- **Physical security**, originally assessed as positive, was compromised during the proposal evaluation period. An individual in the team's facility lacked credentials and authorization, and was immediately escorted from the facility.

- **Assignment duration** was more than twice as long as planned, with detrimental effects on matrixed personnel. Engineers reported inability to complete their functional office tasks resulting in "other program" delays.

RM5 Validity

The ARH contract was awarded in 2006 to Bell Helicopter. The contract later experienced a Nunn-McCurdy breach for significant cost overages. It was acknowledged by the Government Accountability Office (GAO, 2008, p. 43) that the inclusion of immature COTS technologies resulted in significant, unplanned development funding and schedule delays. It was also noted that this program's shortcomings have left a void in the Army's ability to perform armed reconnaissance. Excessive delays and growth in program costs forced the ARH program's cancellation on October 16, 2008, when the Department of Defense failed to certify the program to Congress.

Negative consequences from the physical security breach, communication system inadequacies, and other noted RM5 risks could have been avoided had RM5 been formalized. However, the method was novel and nonstandard, impeding its adoption in the Product Office. ARH subsequently experienced a Nunn-McCurdy breach as a result of technical challenges and cost overruns associated with many of the RM5 risks. The author contends a more formal treatment of RM5 would have uncovered and highlighted several "show-stopping" risks.

Other Model Uses

Other uses for the model include applying it specifically to identification of existing, rather than projected, program issues. This could provide managers a snapshot of information that would otherwise escape attention and provide them with the insight to head off problems. Likewise, RM5 could be used to identify strengths or opportunities that were previously unrecognized and could support or provide visibility to a program.

In all of the above cases, the potential for cost savings or revenue generation is apparent since reducing risks or capturing opportunities are means to improving the bottom line.

Furthermore, having a model to complement existing SE tools provides an additional decision aid to validate current assumptions or to promote ideation for new process/product development.

Additional Models

Other management tools adaptable to RM or SE functions include, but are not limited to:

- Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis for requirements development
- Gap analysis for trade studies (Robbins & Coulter, 1996, pp. 264–265)
- Value Chain analysis for determining value added from technical processes (Crawford, 1997, pp. 480–481).

SWOT ANALYSIS

SWOT analysis (Figure 5) can be performed by compiling a list of organizational attributes applied to each of these categories. This allows management to determine where resources need to be allocated to either shore up or scale back attributes to optimize program performance.

FIGURE 5. SWOT ANALYSIS

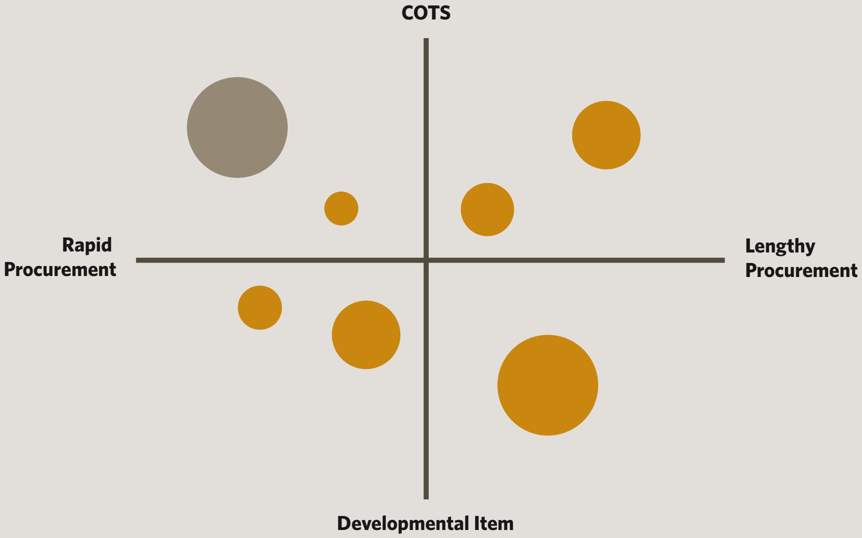
Strengths	Weaknesses	Opportunities	Threats
Subject matter experts	Insufficient funding	Contract Personnel	Budget cuts
Certified processes	Process software outdated	Develop software internally	International standards
Market demand	Production limitations	Outsource production	Loss in quality

GAP ANALYSIS

A gap map (Figure 6) employs a two-axis, four-quadrant graphic depicting variables of interest to the systems engineer. Variables could be metrics relating to cost, schedule, and performance, for example; however, the axes are not restricted to specific categories. The systems engineer determines what is of value or interest.

The space is populated to show occurrences of the variables or lack thereof. Should a particular quadrant, for example, be void of data points, this could be an indication of an opportunity or perhaps a deficiency in the enterprise. To demonstrate the scale of an occurrence, symbols (e.g., circle) are sized accordingly. For instance, if many COTS systems were identified in a quadrant, the size of the symbol would be indicative. Conversely, few occurrences would be represented as a small symbol.

FIGURE 6. GAP MAP

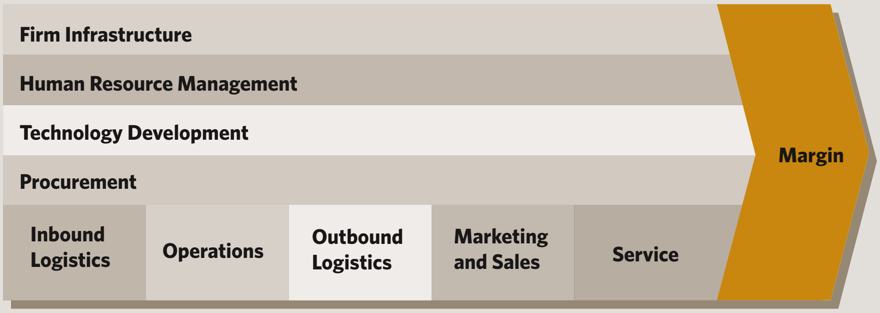


Finally, an opportunity or deficiency could be shown as a dashed, unfilled symbol—scaled to show the magnitude of the gap.

VALUE CHAIN ANALYSIS

The value chain (Figure 7) is comprised of the functions performed to create a product or service. A margin is depicted to highlight the value added for the customer. This would be a useful model for trade studies to represent alternative approaches and determine which produces the greatest margin or best value.

FIGURE 7. VALUE CHAIN


Firm Infrastructure
Human Resource Management
Technology Development
Procurement
Inbound Logistics
Operations
Outbound Logistics
Marketing and Sales
Service
Margin

The elements of the value chain are defined as follows:

Firm infrastructure—Support of entire value chain, such as general management, planning, finance, accounting, legal services, government affairs, and quality management

Human resource management—Recruiting, hiring, training, and development

Technology development—Improving product and manufacturing process

Procurement—Function or purchasing input

Inbound logistics—Materials receiving, storing, and distribution to manufacturing premises

Operations—Transforming inputs into finished products

Outbound logistics—Storing and distributing products

Marketing and sales—Promotion and sales force

Service—Service to maintain or enhance product value (Crawford, 1997)

Conclusions

The multidisciplinary aspects of strategic management tools lend themselves to other uses. This article focused on one tool to present this approach as it pertains to RM. However, it is apparent from the other models presented that the overlap between strategic management and SE yields opportunities for similar analyses (della Cava, 2009). Opportunities exist to extend this approach to broad SE disciplines or focus the model on specialty domains. Examples include technology readiness, information assurance, and environmental considerations.

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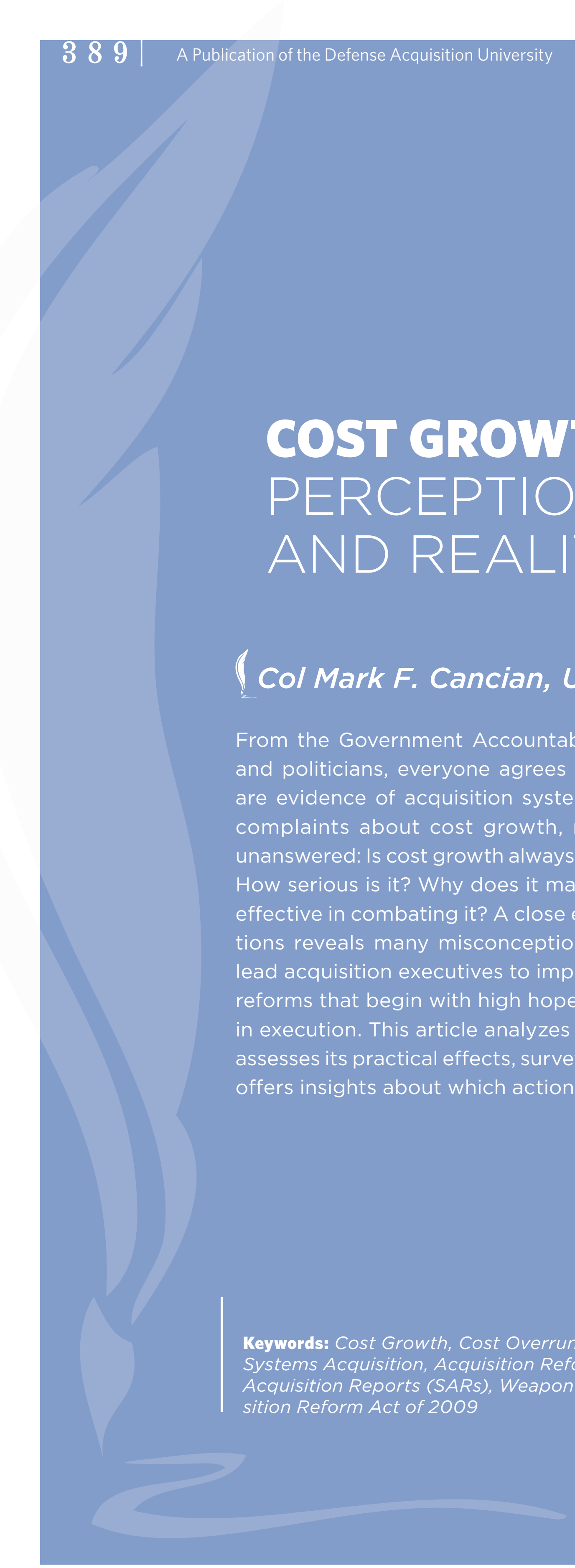


COST GROWTH: PERCEPTION AND REALITY

Col Mark F. Cancian, USMCR (Ret.)

From the Government Accountability Office to think tanks and politicians, everyone agrees that rising weapons costs are evidence of acquisition system failure. However, in the complaints about cost growth, many basic questions go unanswered: Is cost growth always bad? What is cost growth? How serious is it? Why does it matter? What tools are really effective in combating it? A close examination of these questions reveals many misconceptions. These misconceptions lead acquisition executives to implement an endless cycle of reforms that begin with high hopes, yet prove disappointing in execution. This article analyzes the nature of cost growth, assesses its practical effects, surveys the recent literature, and offers insights about which actions are most effective.

Keywords: *Cost Growth, Cost Overrun, Weapon Systems Acquisition, Acquisition Reform, Selected Acquisition Reports (SARs), Weapon Systems Acquisition Reform Act of 2009*

image designed by Harambee Dennis »

ACQUISITION
REALITY

"The cumulative cost overruns are...staggering...
and the problems are pervasive."

—Gene L. Dodaro, Acting Head of
the Government Accountability Office
Letter to Congress, March 30, 2009

Our weapon systems acquisition process is a perpetual scandal. Investigation after investigation finds deep-seated faults and unsatisfactory outcomes. Cost growth figures prominently in these critiques. From the Government Accountability Office (GAO) to think tanks and politicians, everyone agrees that rising weapon systems costs are evidence of system failure. Typically seen as a consequence of shortsighted system advocates, technology-obsessed military services, greedy contractors, and inattentive government officials, cost growth is viewed as a simple system failure that needs "fixing."

In the moral indignation that arises from this unsatisfactory state of affairs, many basic questions go unanswered: Is cost growth always bad? What is cost growth? How serious a problem is it? Why does it matter? What tools are really effective in combating it? A close examination of these questions reveals that much of what people believe about cost growth is wrong, and these misconceptions lead them to an endless cycle of reforms that begin with high hopes, yet prove disappointing in execution. Although recent legislation (Weapon Systems Acquisition Reform Act of 2009) may be helpful, disappointment could continue unless decision makers, program proponents, and acquisition professionals are realistic about what can and cannot be done. This article analyzes the nature of cost growth, assesses its practical effects, surveys the recent literature, and offers insights to policy makers on which actions are most effective.

Is Cost Growth Always Bad?

Discussions about cost growth presume that it is always bad and that policy makers should take drastic actions to prevent it. A cautionary tale from the early days of the Republic shows that the situation is more complicated than the usual morality play about shortsightedness and incompetence.

In 1794, the young United States authorized the construction of six frigates (*United States, President, Congress, Constitution, Constellation,* and *Chesapeake*). Intended to be the major units of the new Navy, the ships represented the aspirations of an ambitious but inexperienced institution. In execution, all the pathologies of today's weapon systems acquisition were evident. Toll (2006) describes the history and construction of these ships.

- An innovative but unconventional design was criticized as "extravagant."
- A multi-mission requirement for irregular warfare (anti-piracy) and high-intensity warfare (against major powers such as Great Britain) put conflicting demands on the design.
- Use of exotic materials delayed construction and raised costs. (Key hull components required live oak, which had to be imported from inaccessible coastal areas in the South.)
- A divided political establishment argued over the need and cost.
- Contracts were spread around all the northeast states to ensure political support.
- Cost growth caused schedule slippage and program instability.
- Congress, alarmed at the costs and delays, conducted inquiries and railed against waste.

But the story did not end there. In service, the ships were spectacular successes. Over the course of their careers, they fought 11 combat actions, winning 8 and losing 3. The exploits of the *Constitution* particularly encouraged the young nation. These successes were achieved while badly outnumbered and fighting against the two best navies in the world—the British and French. How was this possible? The advanced design that caused so many problems during construction also gave the ships a decided advantage over other ships in their class. They could defeat any ship with comparable speed and outrun any ship that was more powerful. The unexpectedly high cost bought capabilities that proved important in war.

Substitute for frigates the M-1 tank, F-15 fighter, or Ohio-class submarine and the story moves forward two centuries. All of these programs had unexpectedly high costs, but proved world class in operation. The existence of cost growth therefore does not necessarily mean that the acquisition was a mistake.

What is Cost Growth?

Most of us call to mind the same informal definition of cost growth—when something costs more than expected. (For clarity, cost accounting professionals sometimes make a distinction between *cost growth* and *cost overrun*. Cost growth is more general and is the term used here. Cost overrun is used for higher than expected costs on a particular contract.) The vigorous debates about cost growth all assume that there is an agreed-upon definition for this concept called cost growth. In fact, several incompatible definitions exist. A detailed analysis is therefore in order.

All analyses of cost growth use the Selected Acquisition Reports (SARs) as their database.[1] The SARs are statutorily required and comprise the department's official statement about the status of major acquisition programs (SARs, 2009). Despite some imperfections in their construction, SARs have been judged suitable for cost analyses when used appropriately (Hough, 1992). As a result, all analyses use the SAR's definition of a program's baseline—the configuration, characteristics, quantities, and cost estimate at the time the program is officially established (Milestone B). Any increases are measured against this baseline. (Although programs are rebaselined at Milestone C [initial production], so previous cost growth is, in effect, wiped away, analyses of cost growth generally ignore this rebaselining and use the original estimate.)

SARs divide cost growth into seven components: Economic (inflation), Quantity, Schedule, Engineering (performance characteristics), Estimating, Other (e.g., labor unrest, hurricane), and Support (unique facilities or maintenance equipment). This division of cost growth into seven components, however, is where definitions diverge.

Economic (inflation) is excluded from most analyses because it is external to the acquisition system and distorts comparisons. Inflation is the general increase of prices in the economy. Because this is a national economic phenomenon, the acquisition system or program managers have no control over it.

GAO uses all the other categories in its analysis, including quantity. Any increase in any category is cost growth because they must all be paid for. However, most other analyses exclude quantity. If a program's quantity increases, is this cost growth? If quantity declines, is this successful cost containment? The question has important implications. For example, when quantity is included, the F-22 appears to be a successfully managed program because it came in under its original cost estimate. The cost per aircraft doubled, but because the number of aircraft procured declined by 60 percent, the overall program was less expensive. Conversely, the Stryker combat vehicle appears to be poorly managed even though per-unit costs have remained relatively stable. The vehicle was a surprising success in Iraq, so the Army procured more than originally planned. Further, every vehicle lost in combat was replaced. With quantity included, the Stryker program shows large cost growth. John Young, then-Under Secretary of Defense for Acquisition, Technology and Logistics, made the argument for exclusion: Because acquisition quantities are set by factors external to the acquisition system, "purchasing greater quantities, and the associated cost of these items, is not acquisition program cost growth and does not reflect poor acquisition management" (Peters, 2009, para. 11). He made similar but broader arguments in a memo to the Secretary of Defense (Bennett, 2009).

The defense consulting companies, Institute for Defense Analyses (IDA) and RAND, have done extensive analyses of cost growth over the years. Both exclude escalation and quantity changes in their calculations. The Nunn-McCurdy provision, which sets benchmarks on program cost performance,[2] also, in effect, excludes quantity and escalation by using unit cost as its metric.

IDA further tried to divide cost growth into *decisions* and *mistakes*. Decisions, which accounted for about a third of cost growth, captured cost increases that were caused by explicitly made decisions for whatever reason, the notion being that these were consciously accepted and were not mistakes as people understand them (McNichol, 2004, pp. 18–22). About half of decisions actually acquired some additional capability, so the final system was not the same as the one initially estimated.

None of these definitions includes what is called "intergenerational" cost growth, that is, the tendency for new systems to cost more than the systems they replaced. Thus, F-22 fighters cost more than F-15s, LPD-17 amphibious ships cost more than LPD-4s, and M-1 tanks cost more than M-60 tanks. Even if costs could be forecasted accurately and cost growth disappeared, the current generation of systems would still be expensive and require large budgets to acquire and support—a significant management problem in itself (Muczyk, 2007; Christie, 2008, p. 22).

How Serious a Problem is Cost Growth?

Ironically, although GAO's analysis grabbed headlines with its finding of cost growth at 26 percent, the amount is a lot larger when measured over a program's full life cycle.

GAO measured programs at a single point in time. GAO's 2009 analysis, for example, included 95 Department of Defense (DoD) acquisition programs defined as major and for which a SAR was produced. Cost growth was the amount that the total cost of these programs had increased from their baseline (excluding inflation). However, major acquisition programs run for many years. As a result, a snapshot in time captures some programs in their maturity—when most cost growth has occurred—while other programs are in their infancy before much cost growth can take place. In effect, this methodology measures cost growth at the program midpoint.

IDA and RAND did studies that analyzed programs over a lifetime in order to capture the full extent of cost growth. The results—even adjusting for quantity and escalation—were high. RAND found growth of 46 percent, with the amounts varying significantly by type of equipment, from 130 percent for launch vehicles to 23 percent for electronics (Arena, Leonard, Murray, & Younossi, 2009). IDA, using a different methodology, found 45 percent for development and 28 percent for procurement (McNichol, 2004). (Procurement cost growth in the IDA study may have been understated because of the study's cutoff date). Significantly, IDA found that cost growth was concentrated in about 20 percent of the programs, which had very high cost growth, thus skewing the average (McNichol, 2004;

McNichol, Tyson, Hiller, Cloud, & Minix, 2005, p. 6). In other words, high cost growth was not a phenomenon across the board but concentrated in a relatively few programs. Other lifetime studies by Ballistic Missile Defense Organization and Naval Air Systems Command report similarly high lifetime cost growth—40 percent and 50 percent respectively (Sipple, White, & Greiner, 2004, pp. 81–85).

Is Cost Growth Getting Worse?

GAO's analysis purported to show that cost growth became much worse from 2000 to 2007: 6 percent in 2000 versus 26 percent in 2007 (GAO, 2008).[3] This analysis was published during the 2008 presidential campaign and appeared to imply that the Bush Administration had been especially lax in its oversight of weapons acquisition. However, GAO's finding of lower cost growth in 2000 was entirely the result of reduced quantities from the end of the Cold War. When adjusted for quantity, cost growth was constant. Cost estimating actually improved, though engineering changes (some of which produced new capabilities) worsened.[4]

Comparisons such as this are also on shaky ground because they show when the cost growth became apparent, not when it was caused. For example, in 1996 the Navy's H-1 Upgrade program was formally established (Milestone II), with an estimated research, development, test and evaluation cost of $538 million and procurement cost of $2.255 million for 280 aircraft. The program soon developed troubles, requiring management and personnel changes. In 2002, it was finally restructured, having breached the Nunn-McCurdy limits. By 2005 costs had doubled, attributed mainly to faulty initial cost estimates. For this reason RAND and IDA, in their analyses, attributed historical cost growth to the date when a program was formally established (generally Milestone II or B), not to when the estimates were changed.

Both the IDA and RAND have done historical analyses of cost growth over long periods of time and adjusted their data for changes in quantity. Their general conclusion is that cost growth has remained high over the last two decades despite often intensive efforts at reform.

IDA found that cost growth declined in the period 1974–1983 when many now-standard cost control measures were introduced, e.g., SARs and independent cost reviews. Since then, the level has been remarkably constant, except for a spike during the Reagan buildup in the 1980s. Although IDA's analysis ended in 1997, its high and continuing level of cost growth (about 25 percent overall) showed no large decline that GAO was claiming just 3 years later (McNichol, 2004; McNichol et al., 2005, p. 2).

RAND similarly found higher cost growth in the 1970s and lower growth in the 1980s and 1990s. Growth in the 1990s appeared to be lower than in the 1980s, but RAND judged this to be a result of the fact that many programs in the 1990s were not yet finished experiencing cost growth when the study ended. When RAND adjusted for ongoing programs, the 1990s had the same level as the 1980s (Younossi, Arena, Leonard, Roll, Jain, & Sollinger, 2007, pp. 19–23, 31–39).

Does Cost Growth Matter?

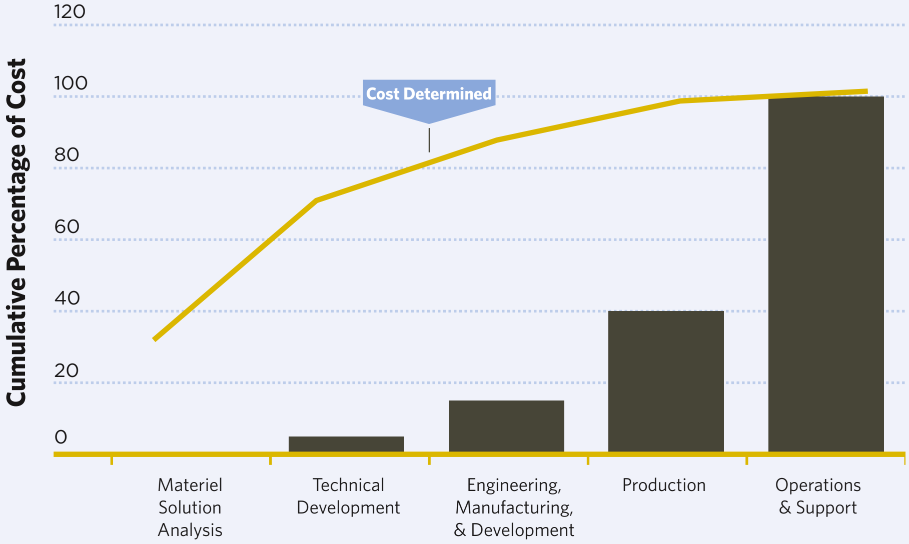
Cost growth does matter, but as analysis indicates, not for the reasons usually ascribed. The usual construct states that, "every dollar spent on cost growth takes money from something the troops really need." Thus, if a system was projected to cost $5 billion and ends up costing $7 billion, $2 billion was "wasted." The implicit assumption is that the system in question could have been acquired for the original cost estimate if only the process had worked (McNichol, 2004, pp. S-2, 9). This is generally not true. *You can't produce a Ferrari for the price of a Chevrolet no matter what the salesman said.* That is, a Ferrari costs a lot because of its features—a V-12/8400 rpm engine, aerodynamic body, high-performance suspension, and leather interior. The fact that the salesman quoted a low price does not make the features cost any less.

YOU CAN'T PRODUCE A FERRARI FOR THE PRICE OF A CHEVROLET NO MATTER WHAT THE SALESMAN SAID.

The F-22 provides a defense example. From the beginning, the aircraft was designed to include many cutting-edge features—supercruise (the ability to fly at supersonic speed for an extended time, not just sprint for a short period); stealth (never previously incorporated into a fighter); integrated avionics; and high-performance sensors. DoD originally estimated that producing these capabilities would cost $24 billion in research and development, and $96 million per aircraft for procurement (FY 2009 dollars). In any event, the research and development costs increased by 50 percent, and the cost to procure each aircraft doubled. "Cost discovery" might be a better term for the process of updating estimates because in retrospect it was clearly impossible to produce the stated capabilities for the originally estimated price.

This is not to say that all acquisition actions to contain cost are futile. Many have real value. Prototyping, for example, engenders design competition and demonstrates technologies; careful selection of contract type gives the producer incentives for better performance; and delaying production until development is complete avoids expensive retrofitting. However, there are limits to what these actions can accomplish. The Figure

FIGURE. COSTS DETERMINED V. FUNDS EXPENDED



(Gansler, 1989, p. 157)

makes the key point: Most of the cost of a system is locked in when the key capabilities are determined but before much money is spent. Starting ambitious programs is easy because early funding demands are low, uncertainty is great, and optimism reigns. Only later, once programs are well established and the magnitude of the challenge is understood, do the true costs become apparent.

Two Reasons Why Cost Growth Does Matter

First, with more accurate estimates decision makers might make different decisions; and second, cost growth acts like a tax, squeezing all acquisition programs and causing inefficiencies from reduced quantities and stretched schedules.

MAKING DIFFERENT DECISIONS

If the true costs of a weapon systems program were known from the beginning, then decision makers might make different choices. Before launching a new acquisition program, the Services conduct an analysis of alternatives[5] that looks at a variety of options. A low cost estimate for one option makes it more attractive and thus distorts the decision-making process. Frequently, these options involve buying a new system or upgrading an existing system. Because there is generally more uncertainty with a new system, the risk of underestimating costs is much greater, particularly when the new capabilities are militarily attractive and sponsors become strong advocates.

Are there examples where decision makers might have made different choices? Although past acquisition decisions cannot be replayed with different cost estimates, subsequent history can give useful insights. In the recent past, several programs have been cancelled, at least in part, because of unexpectedly high costs: the Army's Comanche helicopter, the Navy's DDG-1000 destroyer, and the Air Force's Transformational Satellite Communications System (TSAT). Although we cannot be sure that decision makers would have made different decisions if they had known the true costs, the evidence indicates that they would have.

IF THE TRUE COSTS OF A WEAPON SYSTEMS PROGRAM WERE KNOWN FROM THE BEGINNING, THEN DECISION MAKERS MIGHT MAKE DIFFERENT CHOICES.

- Comanche was the Army's planned new-generation armed reconnaissance helicopter. Begun in 1982, unit costs had doubled, and the schedule slipped by a decade when the Army cancelled it in 2004. Instead, the Army opted to fund a wide variety of aircraft programs, noting that for the 120 Comanches it had planned to buy over 5 years, it would instead buy 800 other helicopters (Brownlee, 2004). For the $6.9 billion it had already invested in Comanche—without receiving any operational aircraft—the Army could have upgraded 350 of its AH-64 attack helicopters from the older "A" model to the modern and far more capable "D" model.
- In 2009, the Navy cancelled the DDG-1000 program, its next-generation surface combatant, mainly because of high costs, though also because of mission limitations. Instead, the Navy will buy additional DDG-51s. If it had made that decision initially, the Navy could have bought 13 of the latest version of the DDG-51 class for its $23 billion investment in three DDG-1000s.
- After spending $3.5 billion on TSAT only to see costs rise and the schedule slip, the Air Force cancelled the program in 2009. Instead it will buy more of the existing satellite designs. For its investment in TSAT, the Air Force could have bought seven of the modern and already developed Advanced Extremely High Frequency and Wideband Gapfiller satellites and avoided a threatened gap in coverage.

SQUEEZING PROGRAMS

Cost growth also acts as a “tax” on acquisition programs. That is, to offset their own and other’s cost growth, acquisition programs have to continually find internal savings, generally by cutting quantities but also by slowing development work, reducing testing, and cutting support equipment. This produces a downward spiral. Reduced quantities spread fixed costs over fewer units and increase their costs, so even fewer units are bought. Instability in production disrupts suppliers’ ability to plan and therefore establish efficient procurement chains. Slower development causes schedule delays. Reductions in testing increase risk of unexpected performance problems. Cuts in support equipment lead to low readiness rates when the equipment is fielded.

To reduce these secondary effects, acquisition officials have often adopted a “buy to budget” strategy, i.e., forcing each program to make accommodations within its own budget and not inflict instability on others. This is not always possible, however, because some programs are such high priority that they must be maintained, even at the price of destabilizing other programs. The effects go beyond the acquisition system. Because quantity is frequently cut to accommodate higher unit cost, what suffers, as Tom McNaugher (1989) argues, is “any semblance of rational force planning” (pp. 135–142). Force size and composition are set by the dynamics of the acquisition process and not by warfighting analysis.

So What to Do?

Because the acquisition process has been a perpetual scandal, efforts at reform have been continuous. Dozens of panels, reports, initiatives, and directives have made recommendations seeking to improve performance. These recommendations fall into several categories, and the analysis described previously shows why they have widely different effects.

One set of reforms are rhetorical—exhorting contractors to do better, railing about greed, and setting targets for improvement. These accomplish little but do set a tone, which may have some political value.

A second set focuses on reporting. Reporting can be bureaucratically burdensome, but is generally perceived as noncontroversial and is therefore politically attractive. Congress especially gravitates towards establishing reporting requirements because it finds process changes easier to deal with than policy changes and often uses the one to attain the other in an indirect way (Aspin, 1978). Reporting does have value. While it cannot reduce cost growth, it can reduce surprises. That is, it facilitates the process of cost discovery and can alert decision makers to problems earlier. Once alerted, decision makers can restructure or terminate a program, though generally only after a lot of money has been spent. However, because reporting is retrospective and typically occurs on established programs, it cannot change the underlying cost growth dynamics. The recently passed Weapon Systems Acquisition Reform Act establishes both new reporting and new oversight requirements—the effects of which are not yet clear.

A third set focuses on acquisition strategies to better manage programs. Some are employed before cost growth occurs—prototyping, funding stability, technology maturity, or incentive-type contracts. These are widely believed to be helpful. However, analysis of the actual effects of various acquisition strategies to control costs is more ambiguous than one would expect, i.e., it is not clear whether these strategies actually work (Arena et al., 2006, pp. 13–16; Lovell & Graser, 2001; Monaco & White, 2005).

Some acquisition strategies are employed after growth has occurred and, typically, after a Nunn-McCurdy breach that requires explanations and justifications to Congress. These strategies—"Tiger Teams," personnel changes, program restructuring—generally mean more efficient management of the train wreck rather than actually preventing the wreck itself.

The final set focuses on program fundamentals and can potentially have large cost impacts.

- **Early, accurate, cost estimates.** This is the time when decision makers have the most latitude, and based on these estimates, they can make different choices. As programs progress and gain momentum, options narrow. Unfortunately, the less mature a program, the less certain the cost estimates. The Weapon Systems Acquisition Reform Act, by strengthening DoD's cost estimating organization, might be helpful in this regard.
- **Judiciousness in starting new programs.** If cost growth acts as a tax, then Service leadership ought to resist the temptation to satisfy internal advocates by starting as many new programs as possible. Aggressive acquisition reform efforts may mitigate cost growth, but history indicates that future budgets get squeezed by a variety of unexpected pressures—acquisition cost growth, rising personnel and health costs, operational commitments, or senior leadership initiatives. Therefore, if the military services commit every available budget dollar to new programs, with the hope of muddling through, then program instability will be inevitable.
- **A focus on requirements.** Once requirements are set, the ability to control costs becomes very limited. The Weapon Systems Acquisition Reform Act seeks to strengthen DoD's mechanisms for making such trade-offs by requiring both AoAs and the Joint Requirements Oversight Council (JROC—the Joint Staff's requirements-setting body) to consider trade-offs among cost, schedule, and performance. The direction

> is appropriate, but the effort has been made before, e.g., the "cost as an independent variable" policy of the last decade, which sought to encourage trade-offs among cost, schedule, and performance (Aldridge, 2002).

Secretary of Defense Robert Gates, in his speech laying out the new administration's defense budget, criticized "exquisite requirements" in weapon systems and promised to keep requirements "reasonable" (Gates, 2009). His judgment was just right and gets at the most fundamental cost driver. The current absence of a peer, existential threat may open the door to more evolutionary developments, which typically are less technologically ambitious and have less cost growth (Muczyk, pp. 465–466). However, the execution will be difficult—what is "exquisite" to one person is "reasonable and necessary" to another.

Author Biography

Colonel Mark F. Cancian, United States Marine Corps Reserve (USMCR) (Ret.), teaches defense analysis as an adjunct professor at Johns Hopkins School of Advanced International Studies. Colonel Cancian served in Washington, DC, as both a military officer and a senior civilian, where he gained extensive experience on weapon systems acquisition programs. At Harvard University, he oversaw a major research program on major systems acquisition. Colonel Cancian received his BA and MBA from Harvard University. He has written widely on national security topics.

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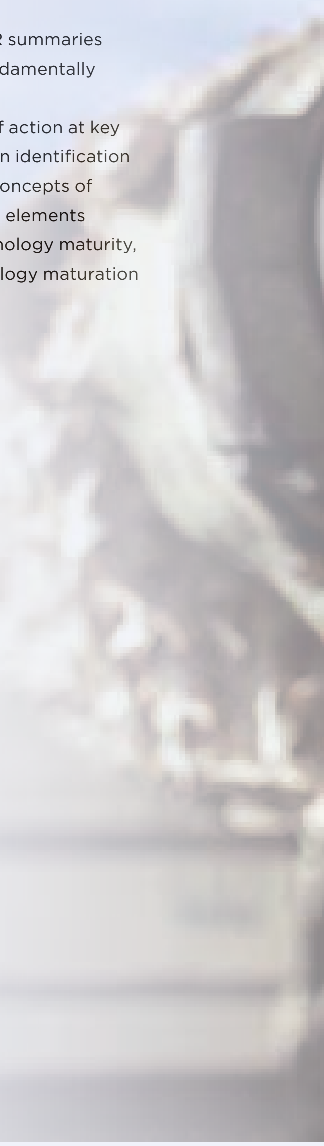

ENDNOTES

1. The Selected Acquisition Reports (SARs), initiated in 1968 and congressionally mandated in 1974 (10 U.S.C. § 2432), were intended to be a tool for cost control. Annually, each major acquisition program reports information on cost, quantity, performance, schedule, and contract status. Costs are shown in both base-year (constant) and then-year (inflated) dollars. “Major acquisition program” is defined by DoD Instruction 5000.2 (p. 33) and 10 U.S.C. § 2432. As of September 2009, 93 programs are defined as “major.” A summary of SAR information is released publicly, but the full reports are restricted.
2. The Nunn–McCurdy provision, 10 U.S.C. § 2433, Unit Cost Reports, is designed to curtail cost growth in American weapons procurement programs. It requires notification to Congress of cost growth more than 15 percent and calls for the termination of programs whose total cost grew by more than 25 percent over the original estimate, unless the Secretary of Defense submits a detailed justification for continuation.
3. The 2009 analysis showed cost growth down slightly to 25 percent (GAO, 2009, “Analysis of DoD Major Defense Acquisition Progam,” para. 1).
4. Data were extracted from September 30, 2001, and June 30, 2008, SAR summaries (excluding National Missile Defense because the 2008 program was fundamentally different from the 2001 program).
5. Analyses of Alternatives (AoAs) investigate different possible courses of action at key points in the acquisition process. Required by regulation, AoAs “focus on identification and analysis of alternatives, measures of effectiveness, cost, schedule, concepts of operations, and overall risk. The AoA shall assess the critical technology elements (CTEs) associated with each proposed materiel solution, including technology maturity, integration risk, manufacturing feasibility, and, where necessary, technology maturation and demonstration needs” (DoD, 2008).

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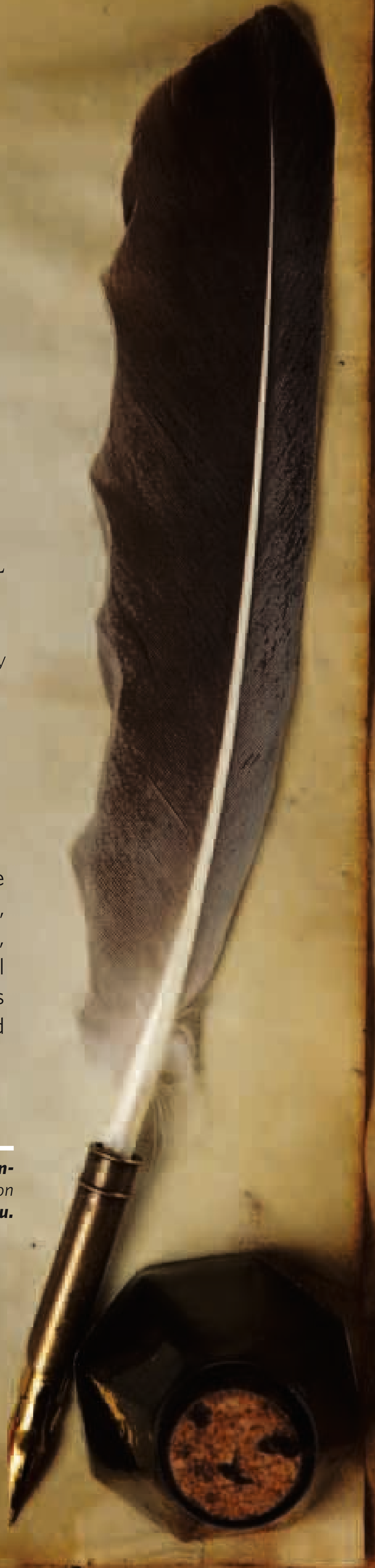

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